"I wish we could derive the rest of the phenomena of nature by the same kind of reasoning from mechanical principles; for I am induced by many reasons to suspect that they may all depend upon certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled towards each other, and cohere in regular figures, or are repelled and recede from each other."

Isaac Newton
The Principia[1]
Cambridge, Trinity College, 1686

"We have the electrical and magnetic sciences, which treat of certain phenomena of attraction, heat, light and chemical action, depending on conditions of matter, of which we have as yet only a partial and provisional knowledge. An immense mass of facts has been collected and these have been reduced to order, and expressed as the results of a number of experimental laws, but the form under which these laws are ultimately to appear as deduced from central principles is as yet uncertain."

James Maxwell
Inaugural Lecture[2]
Paris, Kings College, 1860

"In considering the thermodynamics of biological evolution it is convenient to examine subsystems where different processes of reaching corresponding quasi-equilibrium take place: molecular processes, chemical evolutions, supramolecular evolutions, and evolutions of higher orders such as genera, families, associations, and ecological evolutions, etc. Assuming that the corresponding quasi-equilibria are reached in the processes of general and particular evolutions of the biosphere and its subsystems one can use the Gibbs free energy criteria of equilibrium to predict the degree of evolutionary development of each process."

Georgi P. Gladyshev
On the Thermodynamics of Biological Evolution[3]
Moscow, Institute of Chemical Physics Academy of Science, 1978

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Human Chemistry

Volume One

LuLu, Inc.

Human Chemistry

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Praise for Libb Thims' Human Chemistry:

"We talk about putting 'work' into our relationships all the time—and bringing it to that next level of scientific explanation, is to me what's been the most applicable."

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"I love it! I learned the laws of thermodynamics in college, but I never realized they could be applied to us, our lives, and our relationships."

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— *Georgi P. Gladyshev*, BS Chemistry, PhD Polymer Chemistry
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— *John Avery*, BS Physics, MS Physics, PhD Theoretical Chemistry
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Shared in Noble Peace Prize, 1995[1]

"I would not have understood parts of this if I had not taken honors chemistry; I just don't think everyone would know what integral spins are?"

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— *Urvaksh Patel*, BS Finance and Entrepreneurship

"I'm glad someone can see or is not afraid to look outside the prescribed scale for a change!"

— *Pierre Rousseau,* Phototographer[2]

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"The chapters are wonderfully written. I have a feeling that it will be (Thims) who will get the public's attention about the fundamental change in thinking in science."

— *Jing Chen*, BS, MS, and PhD Mathematics
Author: *the Physical Foundation of Economics an Analytical Thermodynamic Theory* (2005)

"I think that the date of first incorporation of iodine into biological molecular structure (as iodocarbons) might be started in *Cyanobacteria* (as a primitive antioxidant: probably the first antioxidant) about 3.5 BYA, as we reported in our works."

— *Sebastiano Venturi*, MD
Iodine Deficiency, Metabolism, and Evolution Researcher[3]

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"At first, (Thims) theory looks strange, but after time, following further thought and understanding, I did not find any arguments against it … if we have rules for molecular behavior, why not adapt these molecular terms for human behavior; moreover, until human thermodynamics, there had never been a direct link between fingerprints, which reflect the character and health of a person, and DNA – this phenomenon can now be explained."

— *Viktor Minkin*, BS Measurement and IT, MS Photosensitive Devices
Cofounder: Vibraimage Technologies[4]

"I think (Thims) should take a bunch of copies of (his) book, go downtown to a street corner, and just start talking!"

— *Edward Duncan, Graphic Designer*

Contents:

> A structure becomes architecture and not sculpture when its elements no longer have their justification in nature.
>
> *Guillaume Apollinaire,* French poet

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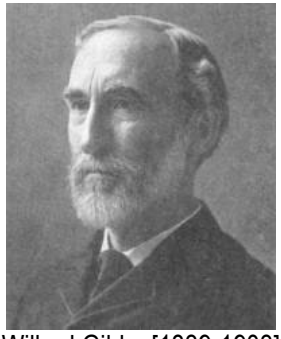
Preface:

"Thank me no thankings,
nor proud me no prouds."
William Shakespeare, English writer

A curious fact of life stipulates that eight-five percent of people will enter into and atomically transform though the following human chemical reaction:[1]

$$Mx + Fy \rightarrow MxFy + Bc$$

That is, a man *Mx* meets and begins to react with a woman *Fy*, they 'bond' into a working intimate relationship $Mx \equiv Fy$, and in time form a child *Bc*.[2] Similarly, as all chemical engineers know, a tight expression called the *Gibbs free energy equation*, developed in 1876 by renowned American theoretical chemist, physicist, engineer, and mathematician Willard Gibbs, can be used to predict the energetic feasibility of these types of chemical reactions.[3]


Willard Gibbs [1839-1903]

$$\Delta G = \Delta H - T\Delta S$$
Gibbs free energy equation

Gibbs, according to German-born American physicist Albert Einstein, 'is one of the most original and important minds in the field of science America has produced'.

In regards to 'bonding', within the *human molecule* (person) there is a great deal of latent energy stored; and only through the correct reaction, i.e. purpose, a process involving either bond formation, reconfiguration, or dissolution, can this energy be released. As nature has shown, subtle dynamic reactions, involving minute changes, significantly those such as *fusion* (nuclear combination), *fission* (nuclear splitting), and *combustion* (reaction with oxygen), can release a relatively large quantity of energy. In the *lithium-6 deuterium reaction*, for instance, where ^{6}Li and deuterium (^{2}H) react to form the highly excited intermediate nucleus ^{8}Be, which then decays

immediately into two alpha particles, 22.4 mega-electron volts (MeV) of energy per nucleon is released. Likewise, in the simple methane *combustion reaction*, where one CH_4 molecule reacts with two O_2 molecules to form two H_2O molecules in the vapor phase, 4.24 eV of energy is released per methane molecule. These same energy-release principles apply absolutely in the course of daily human life, i.e. in human chemical reaction processes. All examples involve the reactive alteration of *fermions*, i.e. ½-integer spin particles, with *bosons*, integer-spin particles. In human reactions, the process involves the reactive alteration of valence electrons with system photons, i.e. between sensory receptors and system information.

The synthesis of principles and theories presented here outline this application. This two-volume book then, is a dissertation embodying the results of original research, substantiating a specific view, which took over a dozen years to mature; metamorphosing, in structure, from a fascinating mental puzzle seeded in '95 as to the obvious and quixotic connection between the ubiquitous Gibbs free energy G which measures the work-output energy released from molecular relationships, and the widespread understanding that love is a chemical reaction.[4] During this period, three books functioned decisively as intellectual stimulators: *The Evolution of Desire* (Buss): regarding mating behaviors, *Genome* (Ridley): regarding writing style, and *A Brief History of Time* (Hawkings): regarding entropy *S,* which is the energy of a thermodynamic system unavailable to do external work, and its curious relation to the organization of human central nervous system.

As to fundamentals, not one word of this textbook, however, would have ever come to fruition if not for the efforts of the great American thermodynamicist Willard Gibbs who formulated the science of *chemical thermodynamics*, which is the study of heat movements and chemical behaviors.[5] This branch of study, as we will show, is the principle science behind all human behaviors—particularly human mating behaviors. Through his efforts, we are now able to measure the energetic quantity *spontaneity*, i.e. reactional-impulses arising from natural feeling or innate tendency without external constraint, for virtually any chemical reaction; including, in theory, human chemical reactions.

The first to begin to quantify 'spontaneity' in human chemical reaction terms was German polymath Johann von Goethe:

> "Nature goes her own way, and all that to us seems an exception is really according to order."

Johann von Goethe [1749-1832]

Specifically, with regard to the theoretical nature and underlying basis of *human chemistry*, e.g. people chemically reacting, falling in love, and releasing functional work-output energy in the dynamics of the process, including those relationships involving break-ups and coupled energy absorptions, we are indebted to the famed German novelist, philosopher, and scientist Johann Wolfgang von Goethe for his 1809 publication of *Elective Affinities*, a scientific treatise on the chemical origin of love.[6]

In this penetrating study of life, work, marriage, and passion Goethe extends the chemical term 'elective affinities' through storyline to human relationships, both intimate and political. According to a review of *Elective Affinities* by Oxford University Press, Goethe conducts an experiment with the lives of people who are living badly. Charlotte and Eduard, aristocrats with little to occupy them, invite Ottilie and the Captain into their lives; against morality, good sense, and conscious volition all four reactants are drawn into relationships as inexorably as if they were substances in a chemical equation.[7]

Historically, *elective affinity*, or its modern synonym 'chemical affinity', symbolized by *A*, refers to the tendency for atoms, molecules, or chemical species to combine by chemical reaction.[8] The name *affinitas* was first used in the sense of chemical relation by German philosopher Albertus Magnus in the year 1250.[9] Isaac Newton, in his 1704 publication *Opticks*, argued that chemical affinity could be explained by virtue of the existence of dynamic attractions and repulsions between chemical bodies in relation to certain chemical 'forces'. Concisely, from English chemist and physicist Michael Faraday's famous 1861 lecture 'On the Various Forces in Nature':

> **Chemical affinity –** the force of chemical action between different bodies; that depends entirely upon the energy which particles of different kinds attract each other.[10]

In this manner, various theories and postulates in regards to the underlying nature of chemical affinities have intermittently been used throughout history to explain why and how chemical species react. Goethe, subsequently, by studying these works and others such as *De attractionibus electivis* by Swedish chemist Torbern Bergman and by attending the weekly lectures of his lifelong friend German chemist Johann Dobereiner, who served as a model for the Captain in the story, was able, in *Elective Affinities*, to present a semi-biographical story in which passion, marriage, conflict, and free-will are all subject to the laws of chemistry and in which the lives of human species are regulated no differently than the lives of chemical species.

By the mid 1850s, chemists such as Julius Thomsen and Marcellin Berthelot had developed a *thermal theory of affinity*, which proposed that all chemical changes are accompanied by the production of heat and that processes which occur

spontaneously will be ones in which the most heat is produced.[11] This hypothesis, however, was later disproved when in 1882 the German scientist Hermann von Helmholtz showed that the true measure of affinity was not given by the heat evolved in a chemical reaction but rather by the maximum work, or *free energy*, produced when a reaction was carried out reversibly.[12] In human life, this translates to the effect that the cumulative action of multitudes of attractions and repulsions, owing to inter-personal human chemical affinities, will on average tend to actuate only those process or relationships which will 'work' the best; not necessarily those which will produce the most heat, i.e. be the hottest.

In 1922, building on the logic of Helmholtz, Belgian mathematical physicist Théophile de Donder formulated a relation between chemical affinity A and Gibbs free energy G. De Donder showed that if we consider a mixture of chemical species, e.g. a system of reactive humans, with the possibility of chemical reaction, the measure of affinity felt between the reacting species is equal to the negative of the Gibbs free energy of formation ΔG for the reaction:[13]

$$A = - \Delta G$$

This connection was significant. Historically, affinity, as mentioned, was used throughout the second millennium not only to explain the phenomenon of chemistry but to explain the phenomenon of dynamic motion as well. In 1620, for instance, English scientific philosopher Francis Bacon developed theories on chemical affinity to explain the inherent nature of motion and its causes. Bacon reasoned that 'dispute and friendship are the spurs to motion in nature, and the keys to her works.'[14] Bacon defined chemical affinity as such 'it is certain that all bodies whatsoever, though they have no sense, yet they have perception; for when one body is applied to another, there is a kind of *election* to embrace that which is agreeable, and to exclude or expel that which is ingrate; and whether the body be alterant or altered, evermore perception precedeth operation; for else all bodies would be like one to another.'[15] This logic, naturally evolved into a conception of elective attraction or *elective affinity*, defined as 'a favorable inclination to one more than to another' or a process in which 'a substance tends to combine with certain substances in preference to others.'[16]

During these formative years, tentative hypothesis were put forward on the problem of chemical affinity arguing that similar substances were assumed to have somehow an attraction or sympathy for one another, e.g. water attracts to water, whereas oil and water repel each other, often summarized as 'likes attract'. In later centuries, with the discovery of positive and negative charges, theories were presented in which chemical affinity could be modeled in terms of the framework of 'opposites attract', e.g. opposite charges attract, whereas like charges repel. Other noted scientists, such as Johann Glauber (1646), Robert Boyle (1661), John Mayow

(1668), and Georg Stahl (1718), all put forward ideas on elective affinity in attempts to explain how heat is evolved during chemical reactions.[17]

In 1923, building on the work of Bergman, Newton, Gibbs, de Donder, and others, and after studying and measuring Gibbs free energies of chemical species for a period of thirty years, two Americans, chemist Gilbert Lewis and physical chemist Merle Randall, published the influential textbook *Thermodynamics and the Free Energy of Chemical Reactions.* Throughout the remainder of the 20th century, according to chemistry historian Henry Leicester, this famous publication led to the replacement of the term 'affinity' by the term 'free energy' in much of the English-speaking world.[18] Hence, it is now known that the thermodynamic quantity free energy, i.e. the dynamic energy portion of a reactive system available for useful work, is a more advanced and accurate replacement for the term affinity used by chemists, of olden days, to describe the 'force' that causes chemical reactions.

Similarly, in 1978 Russian physical chemist Georgi Gladyshev published a controversial, but accurate, article in the *Journal of Theoretical Biology* entitled 'On the Thermodynamics of Biological Evolution' in which differential Gibbs free energy reaction tendencies were utilized as a theoretical basis for the process and dynamics of chemical, biological, and human evolution. In his article, Gladyshev argued that evolution is regulated energetically, i.e. that change is driven by the tendency for earth-bound dynamic systems to evolve towards configurations in which the Gibbs free energy of each subsystem or ecological hierarchy tends to a minimum. Later, building on the success of this exceptional article, Gladyshev published the founding 1997 book *Thermodynamic Theory of the Evolution of Living Beings.* This book was the first of its kind to outline an accurate model in which Gibbs free energy calculations, in theory, could be applied to all spatiotemporal hierarchies of the living world, those including population structures, species evolutions, and social hierarchies, etc., in such a manner so to be able to quantify the 'work of evolution' on an energetic basis.

Over the last hundred years, chemists have frequently blended the concepts of free energy and chemical affinity together to provide a fluid picture of dynamic chemical reactive systems. Belgian Nobel Prize winning chemist Ilya Prigogine, for instance, tells us 'as motion was explained by the Newtonian concept of force, chemists wanted a similar concept of driving force for chemical change? Why do chemical reactions occur, and why do they stop at certain points? Chemists called the force that caused chemical reactions *affinity*, but it lacked a clear definition.'[19] With the development of chemical thermodynamics, over the last two centuries, chemical affinity has found a clear definition in the Gibbs free energy equation. The measure of affinity felt between reactant species can now be energetically quantified. In Prigogine's own words:

> All chemical reactions drive the system to a state of equilibrium in which the affinities of the reactions vanish.

In human romantic reaction terms, the measure of mutual affinity felt between a pair is the measure of the strength or driving force of the relationship. The greater the affinity the greater the drive. Not all relationships (reactions), however, will last. How long a relationship lasts depends on its *reaction rate*. Many will burnout quick and others will continue reacting. In particular, relationships stop working, in the words of Prigogine, when the system reaches a state of equilibrium in which the affinities of the reactions vanish.

In the U.S., to give an idea of *relationship lifetime*, 82 percent of married couples will reach their 5th wedding anniversary, 65 percent will reach their 10th anniversary, 57 percent will reach their 15th anniversary, 33 percent will reach their 'silver' 25th wedding anniversary, and a lucky 5 percent will reach their 'golden' 50th wedding anniversary.[20] Less than five percent of people who marry, however, will ever reach the most-coveted diamond 60th, platinum 70th, or famed oak 80th wedding anniversaries.[21]

Similarly, in terms of *relationship satiety*, i.e. bonding satisfaction, in the U.S only 38 percent of wedded couples say that they are 'happily married.'[22] States of continued unhappiness, however, tend to be short-lived. Of those who divorce, seventy-five percent remarry, half of them within three years.[23] Debonding, detaching, or divorcing reactions are defined in terms of *chemical equations*; such as, for example, wherein a man *Mx* detaches from a relationship with a woman *Fy*, and they go their separate ways, owing to a predominance of physical, mental, and emotional repulsive forces:

$$MxFy \rightarrow Mx + Fy$$

These 'divorce-points', from a chemical or energetic perspective, would indicate a window in time in which the overall affinity felt between the bonded, married, or dating pair vanishes. Such a burned-out or dysfunctional relationship would be at what is technically called *thermodynamic equilibrium*, in which no further useful or functioning work could possibly be obtained.[24] Such reaction periods can be energetically and technically defined as non-evolving or dead relationships.[25] These decoupling points, in human chemical reactions, arise whenever one bonded partner in a fluid relationship, unconsciously, no longer has desire to make the relationship or marriage work.[26]

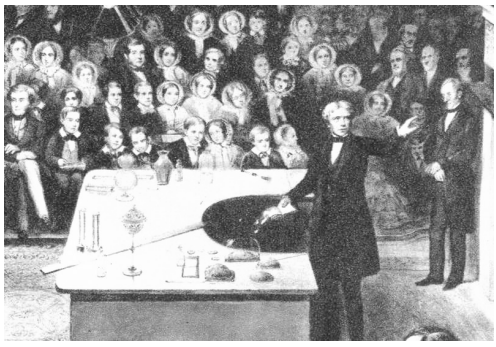
Subsequently, herein, as based on this historical framework of logic, we will be picking up where Newton, Goethe, Helmholtz, de Donder, Gladyshev, and others left off by apply these theories of affinities, chemical forces, free energies, and chemical reactions, etc., to the process and chemical reality of human life. To outline what follows through the lens of film, as art imitates life, it's no surprise that the famous 1999 movie *The Matrix,* which depicts life as an illusion infused reality, illuminates the basic tenets of human chemistry exceptionally well:

> "What is real? How do you define real? If you're talking about what you can feel; what you can taste; what you can smell and see; then real is simply electrical signals being interpreted by your brain."

In the story, computer programmer Thomas Anderson leads a secret life as a hacker under the alias *Neo*. He wishes to learn the answer to the question: 'What is the Matrix?' Cryptic messages appearing on his computer monitor and an encounter with several sinister agents lead him to a group led by the mysterious *Morpheus*, a man who offers him the chance to learn the truth about the Matrix. Neo accepts. Swallowing a red pill, he abruptly wakes up naked in a liquid-filled chamber, his body connected by wires to a vast mechanical tower covered with identical pods.[27]

The movie is a modern-day take on the age old question 'What is Life?' Human life, invariably, is chemically programmed, quantumally triggered, and thermally driven. The 'matrix' of life is a chemical matrix comprised of evolving structural bonds. Programmed changes in the matrix are a result of quantum energy inputs, in the form of photons, deriving from solar thermonuclear reactions.

One of the first scientists to outline the essential points of such a quantum chemical reaction view of life was English chemist and physicist Michael Faraday. In his 1859 Royal Institute Christmas lecture on *The Various Forces of Matter and their Relations to Each Other*, Faraday highlighted the wondrous yet paradoxical nature as to why we stand upon this world:



Faraday's 1856 Christmas Lecture on *Attractive Forces*

The *British Royal Institution Christmas Lectures* have been held annually since 1825. They serve as a forum for presenting complex scientific issues to young people in an informative and entertaining manner.[28] In the mid 1820s Faraday, a former Director of the Royal Institution, initiated the first Christmas Lecture series at a time when organized education for young people was scarce. He presented a total of nineteen series, establishing an exciting new venture of teaching science to young people that was eventually copied by other institutions internationally.

From the opening lines of *The Various Forces of Matter,* Faraday declares 'let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise; and I do think that, to a young person of ten, fifteen or twenty years of age, perhaps the first sight of a cataract or a mountain would occasion him more surprise than he had ever felt concerning the means of his own existence,' which according to Faraday is:

> "How he came here; how he lives; by what means he stands upright; and through what means he moves about from place to place."

Faraday continues 'we come into this world, we live, and depart from it, without our thoughts being called specifically to consider how all this takes place; and were it not for the exertions of some few inquiring minds, who have looked into these things, and ascertained the very beautiful laws and conditions by which we do live and stand upon the earth, we should hardly be aware that there was anything wonderful in it. These inquiries, which have occupied philosophers from the earliest days, when they first began to find out the laws by which we grow, and exist, and enjoy ourselves, up to the present time, have shown us that all this was effected in consequence of the existence of certain *forces*, or abilities to do things, or *powers*, that are so common that nothing can be more so; for nothing is commoner than the wonderful powers by which we are enabled to stand upright: they are essential to our existence every moment.'[29]

This reality, which Faraday alludes to, that we stand upright on a spherically-shaped molecular structure (earth), so to move about on its surface in elegant diurnal activity orbitals, according to very specific choreographed and regimented patterns, has changed little to this very day. The following booklet, subsequently, will be a Faraday-style new millennium lecture on the topic of 'human chemistry', geared towards the above-average young person fifteen years of age. Human chemistry, to note, is an immense subject of study in rudimentary infancy. Herein, we will lay a bare-boned outline in the clearest sense of the word. To foreworn the reader, we

state immediately that much of what one has learned, to date, will need to be discarded as obsolete. Human-life and chemical-life are one and the same; whatever does not hold to this truism must go.

To the reviewers and editors, to all of the thousands of people surveyed, and to everyone at the **Institute *of* Human Thermodynamics**, no amount of thanks compares.[30] To those chemists, biochemists, physical chemists, chemical engineers, etc., who reviewed early copies of this work, we are indebted.[31]

Special thanks is given to a person named Jason from Glenside, a small town in Pennsylvania, with a population of 7,914 (at the 2000 census). In 2001, at the curious age of seven, Jason sent the following interesting query to the *Physics Van Outreach Program*, an online Q&A forum associated with the physics-engineering department at the University of Illinois at Urbana-Champaign:

Q: Is love a purely chemical reaction?

Jason (age 7)
Glenside Weldon
Glenside, Pa, USA

The following answer was returned to Jason from a graduate physics student named Tamara:

A1: No, I don't think so:

There are certainly chemical elements involved in the physical attraction between two people, e.g. pheromones and hormones. But scientists are hard-pressed to find a physiological basis for any emotion, especially love. That's not to say that the basis couldn't be out there, but we're no where close to figuring it out yet. So for the time being, this is more a question in the realm of philosophy than science - but I think you could ask anyone who's ever been in love, and they'd probably agree that there's something more to it than simple chemistry.

Source: Tamara, *Physics Van* Outreach Program
College of Engineering, University of Illinois at Urbana-Champaign

According to the physics of Tamara, there is something more to love than simple chemistry. This ambivalent answer, to put it bluntly, although slightly truthful, e.g. mentioning pheromones and hormones, is completely wrong. The correct answer that Jason should have received is:

A2: Yes, I know so:

Definitively, without the slightest doubt, love is a purely chemical reaction. Furthermore, 66% of people agree that love is a chemical reaction.[32] Moreover, when shown the statement: 'people need chemistry in order for a relationship to work…be it a romantic relationship, a friendship, a societal relationship, or a political relationship, etc.' 92% of people agree with this truism.[33]

Source: Libb Thims, *Human Thermodynamics* Outreach Program
College of Engineering, University of Michigan

Subsequently, the ubiquity of such misinformation propagated about the internet and around the world to young people has been one of the major stimulators for the writing of this book. In other words, if seven-year-olds intuitively believe or understand that love is a 'purely chemical reaction', then why can't an educated chemist, physical chemist, or chemical engineer, etc., come forward to write up a simple textbook outline of this process for the sake of seven-year-olds? As such, thank you Jason for being so inquisitive. Lastly, to Copernicus, Newton, Darwin, Maxwell, and Einstein—in your revolutions we marinade.

Chicago, Illinois
June 2007 L.T.

1 – Love's Paradox:

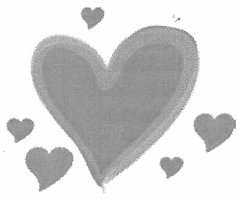
"The only unions which are legitimate forever are those ruled by a genuine passion."

Stendhal, French writer

In science, **human chemistry** is the study of reactions between people.[1] People, according to mass composition measurements, are twenty-six element molecular structures.[2] Human chemistry, subsequently, studies human molecular interactions.

In human life, the formation, dissolution, and transformation of human bonds are of the most immediate and important concerns.[3] The physical laws that define these transformative processes are exactly the same as those that define atomic life.[4] In this direction, love, according to common opinion, is a chemical reaction, pure and simple.[5] The science of chemistry, itself, derives from the 1661 publication of *the Sceptical Chymist* by British physicist Robert Boyle. As such, one might reason that over the last three-hundred-and-forty-six years since the inception of chemistry as a modern science, that at least one fundamentally trained chemist would have since established an outline, theory, or basic formula on the chemistry of love?

From Boyle's work, which was a departure from the mystic alchemical traditions of



Robert Boyle [1627-1691]

the past, the term *element*, i.e. those which are the principles of all mixed bodies, is defined and we are presented with the postulate that:

> "All natural phenomena can be explained by the motion and organization of primary particles."

Moreover, Boyle states that gross matter is composed of clusters of particles and that chemical change results from a rearrangement of the particles and clusters.[6] In these founding statements then, we have the basic components of the human chemical reaction. That is, humans are the clusters and a chemical reaction entails a

rearrangement of the clusters. Thus, ideally, based on Boyle's work, a chemist should have since written a basic outline on human chemistry, specifically on the chemical process, dynamics, and energetics of love; resultantly, so to present these reflections to the world.

To investigate if there is in fact an extant book on 'human chemistry' written by a chemist, shown on the next page, based on '06 Amazon sales rank, are the top-50 books related to or on the science or chemistry of love. This fundamental collection, to a lesser or greater degree, functioned in support of this publiction.[7] Many of these are quite exceptional and two of these books in particular form the foundation of modern human chemistry. These are German writer and scientist Johann von Goethe's 1809 masterpiece *Elective Affinities* (#18) and American marine engineer and industrial executive William Fairburn's 1914 booklet *Human Chemistry* (#49).

Walk of Ideas – Germany, 2006

Goethe's publication is a work of genius. Goethe's IQ, according to psychologist Catharine Cox, from her 1926 book *Early Mental Traits of Three Hundred Geniuses*, is estimated at 210, the highest score that she assigned. People, according to Goethe, as they react, bond, and debond in their various relationships in life are substances in a chemical equation. It is near to indescribable to articulate how fascinating Goethe's *Elective Affinities* is in terms of modern day human chemical theory. He was clearly before his time.

In like manner, Fairburn, whose sociological writings were generally concerned with human potentialities, viewed 'workers' as chemical elements in a well-stocked laboratory and 'handlers' of people as chemists. The primary requirement of a successful handler, according to Fairburn, is a thorough knowledge of the characteristics and temperament of each individual so to optimize the 'reactions resulting from combinations of individuals'.[8] Together, these two writers form the foundation and historical basis of modern human chemistry.

#	Rank	"Human Chemistry" Precursor Books	Credentials	Author
1	*3,722*	*A General Theory of Love*, 2001	Psychiatrists	Lewis
2	*3,934*	*Peopleware – Productive Projects and Teams,* 1999	Consultants	DeMarco
3	*4,019*	*Irresistible Attraction – Secrets of Personal* ***Magnetism***, 2000	Psychologist	Hogan
4	*4,789*	*Why is Sex Fun – the Evolution of Human Sexuality*, 1997	Psychologist	Diamond
5	*4,992*	*The Red Queen – Sex and the Evolution of Human Nature,* 1993	Science Writer	Ridley
6	*5,869*	*The Art of Loving*, 1956	Psychologist	Fromm
7	*6,320*	*How to Make Anyone Fall in Love with You*, 1996	Writer	Lowndes
8	*8,324*	*The Evolution of Desire*, 1994	Psychologist	Buss
9	*9,668*	*The Mating Mind*, 2000	Psychologist	Miller
10	*11,097*	*Why We Love: the Nature and* ***Chemistry*** *of Romantic Love*, 2004	Anthropologist	Fisher
11	*13,558*	*Sperm Wars – the Science of Sex*, 1996	Biologist	Baker
12	*14,671*	***Chemistry*** *– a Novel*, 2006	Writer	DeSimone
13	*24,810*	***Uncoupling*** *– the Dynamics of Separation,* 1986	Sociologist	Vaughan
14	*25,222*	*Dr. Tatiana's Sex Advice – the Evolutionary Biology of Sex*, 2002	Biologist	Judson
15	*43,722*	*The* ***Bonds*** *of Love,* 1988	Psychoanalyst	Benjamin
16	*45,833*	*The New Couple – the 10 New Laws of Love*, 2000	Psychotherapists	Taylor
17	*68, 347*	*Lovemaps,* 1986	Psychologist	Money
18	*80,125*	*Elective* ***Affinities***, 1809	German Writer	Goethe
19	*90,171*	*An* ***Alchemy*** *of Mind – the Marvel and Mystery of the Brain*, 2004	Science Writer	Ackerman
20	*95,786*	*Why Sex Matters – a Darwinian Look at Human Behavior*, 2000	Ecologist	Low
21	*116,752*	*Anatomy of Love*, 1992	Anthropologist	Fisher
22	*126,088*	*Nature's Magic – Synergy in Evolution*, 2003	Economist	Corning
23	*143,705*	*Why We Do It – Rethinking Sex and the Selfish Gene*, 2004	Paleontologist	Eldredge
24	*186,455*	*A Natural History of Love*, 1994	Science Writer	Ackerman
25	*192,522*	*On Love*, 1822	French Writer	Stendhal
26	*196,032*	*The* ***Alchemy*** *of Love and Lust*, 1997	Physician	Crenshaw
27	*197,759*	*A Certain* ***Chemistry*** *– a Novel*, 2004	Writer	Millington
28	*206,647*	*What's Love Got to Do With It? Evolution of Human Mating,* 1996	Anthropologist	Small
29	*215,373*	*Cupid's Arrow – the Course of Love through Time,* 1998	Psychologist	Sternberg
30	*327,740*	*Screen Couple* ***Chemistry***, 2002	Film Professor	Nochimson
31	*335,170*	*Love and Limerence – the Experience of Being in Love*, 1979	Psychologist	Tennov
32	*350,865*	*Love and Love Sickness – the Science of Pair* ***Bonding***, 1980	Psychologist	Money
33	*356,170*	*The Sex Contract – the Evolution of Human Behavior*, 1983	Anthropologist	Fisher
34	*402,637*	*What is Sex?*, 1997	Biologist	Margulis
35	*445,112*	*Sex Signals – the Biology of Love*, 1985	Biologist	Perper
36	*516,027*	*Sex – a Natural History*, 2001	Science Writer	Rodgers
37	*532,760*	*Mystery of Human Relationship:* ***Alchemy*** *& Transformation*, 1998	Psychologist	Schwartz
38	*571,175*	*The Human Sexes – a Natural History of Man and Women*, 1997	Sociobiologist	Morris
39	*624,374*	*The* ***Chemistry*** *of Human Life*, 1919	Physician	Carey
40	*685,272*	*The Making and Breaking of Affectional* ***Bonds***, 1979	Psychiatrist	Bowlby
41	*836,903*	*The* ***Chemistry*** *of Love*, 1983	Psychologist	Liebowitz
42	*854,892*	*The Science of Love,* 2001	Psychologist	Wilson
43	*879,683*	*The Science of Love*, 1991	Sociologist	Walsh
44	*969,827*	*Of Human* ***Bonding****,* 1990	Sociologists	Rossi
45	*1,030,576*	*The Power and Science of Love*, 1927	Writer	Clarke
46	*1,209,877*	*The Ontogeny of Human* ***Bonding*** *Systems,* 2001	Psychologists	Rodgers
47	*1,194,533*	*The* ***Chemistry*** *of Human Behavior,* 1979	Neurochemist	Meltzer
48	*1,997,596*	*Resonance: the New* ***Chemistry*** *of Love,* 1995	Psychologist	Fishman
49	*3,681,725*	***Human Chemistry***, 1914	Writer	Armstrong
50	*3,893,132*	*When* ***Bonding*** *Fails – Assessment of High Risk Families,* 1983	Sociologist	Bolton

The central theme throughout these books is the axiom:

> “love derives out of good chemistry ”

Knowing this, what we note from this list is the peculiar coincidence that aside from Meltzer, whose book is essentially that of neuroscience, and aside from Goethe and Fairburn, not one chemist, biochemist, or chemical engineer is found in this list of authors, in spite of the statistic that the US alone produces some 25,000 degrees, BS, MS, or PhD combined, in these fields per year.[9] Moreover, one can look up the word chemistry in any number of dictionaries, encyclopedias, or references and find the following related definitions:[1]

Interpersonal chemistry – the way two individuals relate to each other.
WordNet Princeton University, 2003

Chemistry – a reaction between two people or the spontaneous reaction of two people to each other, especially a mutual sense of attraction or understanding. *Encarta,* 2006

Chemistry – the interaction of one personality with another or sympathetic understanding. *Random House Unabridged Dictionary*, 2006

Chemistry – a strong mutual attraction, attachment, or sympathy.
Merriam Webster, 2002

Chemistry – the elements of a complex entity and their dynamic interrelation; mutual attraction or sympathy.
American Heritage Dictionary of the English Language, 2000

Chemistry – any complex, especially emotional, change or process; a person’s personality or temperament.
Oxford Illustrated American Dictionary, 1998

Chemistry – instinctual attraction or affinity (from the alchemical sense).
Online Etymology Dictionary, c. 1600

Chemistry – an instinctual, apparently unanalysable, attraction or affinity between people or groups of people; the combination of personal characteristics that create this.
Oxford English Dictionary, c. 1600

The ubiquity of these obvious definitions, lead us to an interesting question: if there are no published chemists in this field, then who is making these definitions?

Another area to consider is the subject of 'online' chemistry. Currently, online dating and matching is a half-a-billion dollar a year industry boasting near to one-thousand online dating sites. One can supposedly go online and for as little as forty dollars per month (*perfectmatch.com*) to as much as ten-thousand dollars (*Debra Winkler Personal Search*) have one's romantic life matched up optimally according to various matching schemes. Other examples include *chemistry.com*, which proclaims to be the first site to recognize chemistry as an essential ingredient in successful relationships, *echemistry.com*, who declares that they have discovered the laws of nature based on thorough scientific research using the scientific method, and *biolovematch.com* that calculates rhythmic compatibility between potential love pairs based on biorhythms (birthdates).[10]

According to a recent '05 Harris Interactive poll, some of these mate-pairing websites, e.g. *eHarmony.com*, are catalyzing as many as fifty marriages per day. One study of 300 married couples showed that people who met online using compatibility matching algorithms reported more marital satisfaction than those who met by other means.[11] Online matching, however, is a relatively new phenomenon; the first site, *Match.com*, was started in '95. Hence, 15-year studies will need to corroborate these findings against the US Census Bureau's benchmark fact that presently 43% of first year marriages end by the 15-year mark.[12]

One of the inherent problems with online-matching, however, is that presently the theoretical basis behind the suggested pairings are formulated by people with degrees in business, anthropology, sociology, or psychology rather than chemistry.[13] Modern-day companies, for example, presently invest large sums money and time to have their businesses, workgroups, and employees match up both synergistically and chemically. These structural reconfigurations and team reassignments are usually administered or processed by an external consulting team of business psychologists who use surveys and feedback to gain insight into the pulse of the group. Websites that cater to these theories include: *humanchemistry.com*, who claim that the principles of human chemistry have operated at a senior level in the commercial world across a range of industries, *humansynergy.com*, who declares that fueling and enhancing the power of teams is the single most efficient way to rapidly surmount complex business challenges, and *humansynergistics.com*, which states that measuring the relationship between human behaviors and performance of teams and organizations helps to actualize their potential.

The term synergy, from the Greek *synergos*, means 'working together' and refers to the phenomenon in which two or more discrete influences or agents acting together create an effect greater than the sum of the effects each is able to create independently. In the 1960s the term first began to be used to describe supposed economies of scale in business, reappearing in the 1990s as a common business buzzword. Synergy usually arises when two persons with different complementary skills or chemical traits cooperate:

Synergy – a dynamic state in which combined action is favored over the sum of individual component actions.[14]

The fundamental example is the cooperation of a man and woman in a couple. The thermodynamic quantification of synergy, as will be explained, is measured by the change in Gibbs free energy, symbolized by ΔG, a measure of the chemical potential of a reaction From a business perspective, the cooperation of people with organizational and technical skills happens quite often. In general, the most common reason why people cooperate is that it brings a synergy. People tend to specialize in order to be able to form groups with high synergy, e.g. division of labor and teamwork.

The recently coined term *corporate synergy* occurs when corporations interact in an energetically favorable manner. Corporate synergy refers to a financial or operational benefit that a corporation expects to realize when it merges with or acquires another corporation. This type of synergy is a nearly ubiquitous feature of a corporate acquisition and is a negotiating point between the buyer and seller that impacts the final acquisition price both parties agree to.[14] In this manner, when people or companies are matched accordingly, both work-output and efficiency increase, and the potential of the group is realized at its best.[15]

Beyond online pairing, in the new age of computer simulations one can go on virtual dates with simulated potential matches, e.g. *Sims 2 Nightlife*, and have the simulated level of mutual chemistry measured via a timed date meter which records sensor interactions, as visual stimulations, chatting, playing, etc.; where if there is no chemistry the date ends. The simulated chemistry measures how well Sims are matched for each other, and goes beyond the normal physical attributes that attraction is typically measured by. Simulated chemistry is determined by values such as compatible aspirations, personality, and interests.[17] Sims can have amazing chemistry together or they can be repelled by each other.[18]

In Hollywood, casting directors are paid great sums of money to pair actors to yield the desired onscreen chemistry. Memorable pairings include: Astaire and Rogers, Tracy and Hepburn, Willis and Shepherd, Bogie and Bacall, etc. The book *Screen Couple Chemistry*, by film studies professor Martha Nochimson, gives an excellent overview of the subject.[19] Film stars with appealing onscreen chemistry, according to Nochimson, become bigger than the films they make, because the central dynamic of their onscreen relationship breaks free from the constraints of any particular story to become a sort of freestanding energy vortex.

The topic of interpersonal chemistry is ever-reaching the news. Over the last fifteen years, magazines have been ripe with tantalizing cover-stories reporting that scientists have unlocked the chemical secrets of human attraction. One of the more famous articles is *Time* magazine's February '93 cover-story article: 'The Chemistry of Love'. In *Time's* famous article, we are told that love rests firmly on the

foundations of evolution, biology, and chemistry. In addition, we are presented with the axiom that love is a vital force, allowing humans to survive through thousands of years. More recently, in the February of '06 *National Geographic*, with the cover-story: 'Love the Chemical Reaction', it is argued that love is a result of a cocktail of brain chemicals, such as dopamine and serotonin, in certain active regions of the brain, such as the ventral tegmental area and the caudate nucleus, where their release provokes states of hyperactivity, recklessness, and exhilaration. Imagine, not only is there a chemistry of love, but love is in fact a chemical reaction! Similarly, in March of '06 *The Atlantic* published the tantalizing cover-story article: 'the New Science of Love' proclaiming essentially that the booming business of online dating has turned into an enormous test-tube social experiment allowing scientists to unravel the secrets of love:

TIME
The Chemistry Of LOVE
Scientists are discovering that romance is a biological affair
(Happy Valentine's Day)
WILD IN CALIFORNIA
NATIONAL GEOGRAPHIC
Love
THE CHEMICAL REACTION
PLUS Turmoil on the Serengeti
Russia's Giant Bears • Meltdown in the Alps
THE Atlantic
The NEW SCIENCE of LOVE
ONLINE DATING HAS BECOME AN ENORMOUS SOCIAL EXPERIMENT— AND IT IS ALLOWING SCIENTISTS TO UNLOCK THE SECRETS OF HUMAN ATTRACTION

The conception of love as a chemical reaction, as we see, is a cover-story topic. Yet what does this mean? How can love be defined as a chemical reaction? A chemical reaction, technically, is a process in which atoms or molecules rearrange themselves to form a new substance or structure, and while doing so either absorb heat or give it off.[20] Heat is defined as energy in transit.[21] Hence, skipping a few technical details then on how energy flows exist or how heat transits in human life, love can exist in a reaction such as, commonly, between a man M and a woman W:

$$M + W \rightarrow MW \qquad [1.1]$$

Love can exist in a *reproductive reaction* in which a baby B is made:

$$M + W \rightarrow MW + B \qquad [1.2]$$

Three friends F can have a strong bonded friendship reaction:

$$F_1 + F_2 + F_3 \rightarrow F_1F_2F_3 \qquad [1.3]$$

A person *P* can love their job, occupation, pursuit in life, or career *C*. In this case, the reaction is more complex; the person is technically reacting with a definitively large number of people through working bonds in, for example, a work group, a corporation, or via connections in society:

$$P + C \rightarrow PC \qquad [1.4]$$

A person can also hate their job *J* and eventually quit:

$$PJ \rightarrow P + J \qquad [1.5]$$

Two men or two women can have homosexual love for each other:

$$M_1 + M_2 \rightarrow M_1M_2 \qquad [1.6]$$

$$W_1 + W_2 \rightarrow W_1W_2 \qquad [1.7]$$

A person can also react bisexually with other people on an alternate basis. A woman may, for instance, in a first reaction produce a child with a man and then later decide to have one or more homosexual relationships. Two hermaphrodites *H,* i.e. intersex people, can bond and fall in love with each other into a transgender relationship, as well as with another heterosexual, homosexual, or bisexual man or woman:

$$H_1 + H_2 \rightarrow H_1H_2 \qquad [1.8]$$

$$H + W \rightarrow HW \qquad [1.9]$$

A clique of five teenagers can break up over intragroup tensions, an argument, or a disrespect issue:

$$F_1F_2F_3F_4F_5 \rightarrow F_1F_2 + F_3F_4F_5 \qquad [1.10]$$

A man and a woman, with three children *C* between them, who happen to hate each other with a passion, can get a divorce:

$$MWC_1C_2C_3 \rightarrow MC_1 + WC_2C_3 \qquad [1.11]$$

A boyfriend *B* and girlfriend *G* can breakup in their troubled relationship and then get back together again several times over in a repetitive manner:

$$B + G \rightarrow BG \rightarrow B + G \rightarrow BG \rightarrow B + G \qquad [1.12]$$

In some cultures, a man can marry three or more women or less commonly a woman can marry three or more men:

$$M + W_1 + W_2 + W_3 \rightarrow MW_1W_2W_3 \quad [1.13]$$

$$W + M_1 + M_2 + M_3 \rightarrow WM_1M_2M_3 \quad [1.14]$$

A person can bond with their pet bird, cat, fish, snake, pony, reptile, monkey, hissing cockroach, sugar glider, panther, ferret, or dog *D*:

$$P + D \rightarrow PD \quad [1.15]$$

A woman can engage in school or college *C* for a number of years. This, however, is a more complex reaction involving, again, one person chemically reacting with a system, group, or network of people:

$$W + C \rightarrow WC \quad [1.16]$$

A husband may have an extramarital affair or a wife cuckold her husband with a child or have a clandestine relationship outside of the marriage, a semi-stable state that can exist for a number of years:

$$MW_1 + W_2 \rightarrow W_1M\text{---}W_2 \quad [1.17]$$

$$M_1W + M_2 \rightarrow M_1W\text{---}M_2 \quad [1.18]$$

A group of ambivalent friends, work groups at the office, or associates in business may shift their affinity relationships with each other in a *reversible* manner. The use of a 'double arrow' signifies a reversible reaction, meaning that the products and the reactants have similar energies. No reaction, however, is completely reversible:

$$AB + CD \leftrightarrow AD + BC \quad [1.19]$$

A grandparent *G* can bond with their grandchildren:

$$G + C_1 + C_2 \rightarrow GC_1C_2 \quad [1.20]$$

A semi-stable married couple *A*, on the brink of separation, may decide, for whatever reason, e.g. the kids, financial reasons, social reasons, etc., to try to 'work on' their failing relationship, by possibly seeking professional help, making new agreements, reconfiguring their working dynamics, breaking off or forming certain internal or

external bonds, etc., all of which involve a significant change in structure or internal constitution of their bonding relationship. The process of this change constitutes a 'relationship isomerization' or *significant change* reaction, i.e. they are still the same bonded couple, but evolved or reconfigured. Namely, as a couple they transform into that of a newer evolved relationship *B*; the couple may further rearrange their bonding constitution every several years into a *C, D*, or *E* type relationship and, in this manner, keep their relationship going for many decades:

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \qquad [1.21]$$

A clothing accessory factory *F* may decide to split into two units or two factories every time its total employee count breaches the 250-275 mark, so as to keep the functional or structural size of the plant at or below the Dunbar number:

$$F_1 \rightarrow F_2 + F_3 \qquad [1.22]$$

The *Dunbar number* 150 represents the maximum number of individuals with whom a set of people can maintain a social relationship, the kind of relationship that goes with knowing who each person is and how each person relates socially to every other person. Group sizes larger than this generally require a hierarchical social structure, more restricted rules, laws, and enforced polices and regulations to maintain a stable cohesion. Conversely, in different situations, sometimes larger groups become more stable as they increase in size. A number of individual states *S*, for example, may decide to form a political alliance, economic union, or united country *C*, and thus be stronger and more powerful as a result:

$$S_1 + S_2 + S_3 + S_4 + S_5 + S_6 \rightarrow C \qquad [1.23]$$

Two rival or tensioned countries C_1 and C_2 can go war, as history has repetitively shown, wherein one country annihilates the other, thereby incorporating its land, remaining people, and wealth into its own newly structured or modified post-war evolved constitution:

$$C_1 + C_2 \rightarrow C_3 \qquad [1.24]$$

Each of these equations is a type of human chemical reaction. Interestingly, in the previously mentioned articles, it is argued that fifty percent of the reaction picture in human pair matching is finding two people who are stable when bonded. Stability, as we will show, is a major thermodynamic factor in the determination of the energetics of human chemical reactions. Instability, typically, is a precursor to change.

In popular culture, throughout history, and in folklore, pseudo-explanations as to how the reaction process of love or life works have been an ever-present feature of humanity. The word *philter* (c.1587), from Ancient Greek φίλτρον meaning 'love potion', is a magical charm, usually a potion, that is said to have the power to cause its imbiber to fall in love with the person who gave it to them. Since ancient times, various love potions, e.g. most famously love potion #9, aphrodisiacs, or elixirs have purported to in some way alter a person's chemistry to enhance the process of falling in love.

In the 1963 movie *The Nutty Professor*, a chemical 'love potion' is formulated to get people to fall instantaneously in love with the person who drinks it; the effects, however, are humorously short lived. In the movie, Julius Kelp (Jerry Lewis) is an unkempt, buck-toothed, introverted, socially inept college professor who invents a serum that turns him into the extremely smooth, obnoxious, girl-chasing hipster 'Buddy Love'. This newfound persona gives him the confidence to pursue one of his students, Stella Purdy (Stella Stevens). At first she despises Love, but she finds herself strangely attracted to him. The formula, however, wears off at inopportune times, often to Kelp's embarrassment, and he must rush back to his laboratory in the hopes that no one will discover his secret.

In the 1992 film *Love Potion #9*, similarly, named after the famous 1959 song by *The Clovers*, starring Sandra Bullock, a pseudo-scientific explanation as to how love potion #9 'works' is explained: 'when swallowed it affects the vocal cords directly so that when you speak microtremors encoded within your voice stimulate tiny little hairs in the inner ear of the opposite sex. The hair vibrates, sending a signal along a nerve to the brain, which in turn produces a combination of mood-altering, endogenous chemicals responsible for the biochemical process of feeling in love. It makes members of the same sex hostile. It only works for four hours at a time.'

Music, in a similar manner, is often filled with analogies and references to the chemistry of love and relationships. In 1961 song 'The Chemistry of Love', written by Al Hazan and Annette Tucker, for instance, was so popular that it allowed Al Hazen to start his own BMI publishing firm called *Chemistry Music*, named after the hit song, which has since produced over one-hundred songs.[22] In 1962, the popular two minute and thirteen second song was recorded by Crystalette Records and sung by Tony Caro with Jimmy Haskell and his Orchestra:[23]

The 'formula' for the chemistry of love, according to this song, is:

1. Start with the heart of a girl.
2. Mix with the heart of a boy.
3. Add a little moonlight from above.
4. Multiply this by what the two are dreaming of.

The 2001 album *All About Chemistry*, by Semisonic, is another example. On the album cover, shown below, we see two test tubes (people) linked or bonded mentally and physically, through some sort of fluid chemical connection or exchange:

The first song entitled 'chemistry' describes how a guy found out about chemistry when he was young and soon began to conduct good-intentioned experiments with a certain fine girl, but soon found that when the two of them were mixed together, they had a bad tendency to explode.[24] The 2002 song 'Just Like a Pill', by P!nk, similarly describes a relationship as being like a drug. In the song, the effects of being sickly attached to boyfriend, in an ambivalent or deteriorating relationship, is described by

the lyric: 'you're just like a pill, stead of makin' me better, you keep makin' me ill.' Virtually every year one can find a new song is written on the chemistry of love.

In the era of the online 'ask-the-community' information centers, one can find a steady stream of users asking for definitions, answers, or opinions on the topic of interpersonal chemistry, the chemistry of love, or human chemistry in general.[25] In June of '06, for example, one user posted the following question to *Yahoo! Answers* for the community to answer: 'is human chemistry real, e.g. when people say: my chemistry allows me to like him or her? How does it work scientifically, and what is real about this chemistry we talk about that makes us to be attracted, loved by someone?'[26]

The answers proffered were the well-known prototypical ones: 'pheromones emitted in human sweat are mainly what attracts one person to another'; that, 'great differences in immune system, as transmitted through pheromones' are needed; such that 'it helps insure that the potential offspring of a union between two people would have the best chances of surviving a microbial onslaught.' Another responded with the generic answer that when a person likes someone 'the chemical makeup of the brain as well as the brain's electrical activity' change dramatically; and that 'a great abundance of mutual physical attractiveness, similarity of characters, and proximity function to drive the forces of liking and loving.'

In sum, what we have outlined is that, in spite of the widespread ubiquity in regards to the use of chemical concepts in human relationship life, no chemist in the history of humankind has ever written book on *human-chemistry*, i.e. chemistry 'between' people? There are, however, numerous books written by chemists on subject of *bio-chemistry*, i.e. chemistry 'within' people. The fact that the chemistry of love is a cover-story topic and yet no chemists have written on this interesting topic is what we will consider to be a modern-day 'love paradox'. A book on the chemistry of love or human chemistry should presumably be written by someone fundamentally trained in the art and science of chemistry. As this has not been the case, the following presentation will be a short discussion on the subject of human chemistry from a chemical engineers' perspective.

Although our focus will concern itself primarily with the chemistry underlying the process of love, i.e. dating, marriage, and mating relationships, we will also touch upon other varieties of interpersonal human chemistry such as day-to-day chemistry, friendship, social, or occupational chemistry, socioeconomic chemistry, and political chemistry, etc. It will be shown that any variation of bond in human life is a *chemical bond* and any variation of interaction or 'exchange' such as visual, aural, tactile, sensual, emotional, physical, financial, economic, political, etc., through all facets of life, constitute a fundamental component of a human *chemical reaction*, generally defined as the combined process of the dissolution of bonds old and the formation of bonds anew.

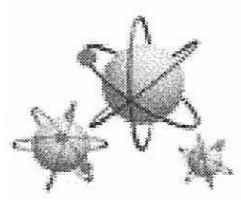
The inquisitive search for an exacting answer to the question ‘what is love’ is one of humankind’s present-day greatest philosophical conundrums.[27] As such, it is very probable over the coming millennium that the ubiquitous phenomena of love as theoretically detailed by the new sciences of human chemistry, the study of reactions between people, and human thermodynamics (chapter sixteen), the study of work, heat, and energy transformations in human life, will result in a fundamental change, for the better, in the course of human knowledge and on the human condition.[28]

2 – The Human Molecule:

"The meeting of two personalities is like the contact of two chemical substances; if there is any reaction, both are transformed."

Carl Jung, *Swiss psychologist*

In biology, the human organism is defined as a bipedal primate mammal.[1] In statistical physics, humans are studied en masse and envisaged as insensate particles of matter.[2] In the abstract field of complexity theory, humans are recursively defined as complex systems.[3] In chemistry, humans are a set of chemical species that share a mate recognition system.[4] Chemical species, in finer detail, as we know, are built from exacting selections of atoms:



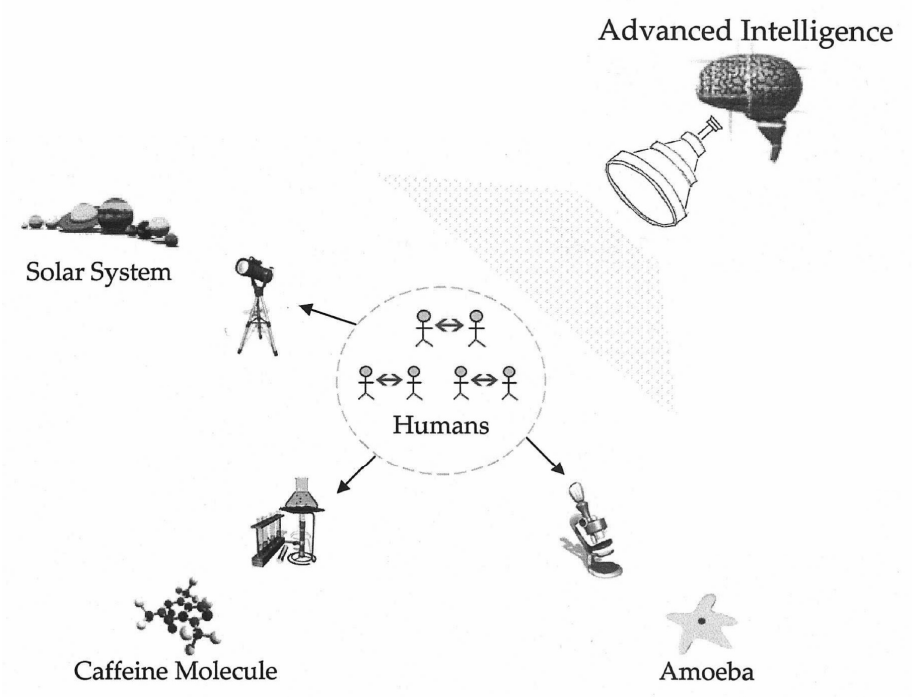
Atoms

In this direction, to facilitate our chemical analysis of the human life process we will move away from an anthropocentric or human-centered view of the universe to that of a *moleculacentric* view of the universe. This viewpoint shift is justified by virtue of the absolute fact that all motile structures on the surface of the earth are molecular structures and in the individual case are defined as unique molecules, i.e. structures comprised of two or more atoms. This viewpoint, to clarify, is an extremely new and revolutionary perspective in the history of human thought.

Molecule – an aggregate of at least two atoms in a definite arrangement held by special forces.[5]

To elaborate on this, the *advanced-intelligence perspective* will be used. That is, to help visualize the concept of human chemistry, imagine that you were a grandiose form of advanced intelligence, of immense size, and you examined under your advanced high-powered microscope a vast collection of strange particles called 'humans'. Curious to explore the intricacies of their operation, you observe, over time, how these particles *interact* with one another, as they zip about over a surface, to yield or reproduce new particles of like, but slightly evolved composition. In

other words, we will study ourselves in the same manner as we currently study other systems, such as the solar system, small chemical systems, or microbial systems, etc. Thus, henceforth, we will utilize the advanced intelligence perspective to visualize humans as small systems of reactive molecules:



In addition, to elaborate further on the concept of 'interactions', whether human or otherwise, we set the following definition:

Interaction – the force exerted by one physical object upon another.[6]

Interactions, in general, can be defined as an effect involving a number of bodies, particles, or systems as a result of which some physical or chemical change takes place. In physics, *fundamental interactions* are four types of essential interactions, i.e. strong nuclear, weak nuclear, electromagnetic, and gravitational that occur between bodies, which together function to account for all observed forces in the universe.[7] Fundamental interactions are mechanisms in which particles interact with each other in ways that cannot be explained by another more basic interaction. Every observed physical phenomenon, human life included, from galaxies colliding with each other to quarks jiggling around inside a proton, can thus be explained by interactions.[8] Electromagnetic interactions are responsible for the forces that control human life and in particular chemical reactions.[7]

From the advanced-intelligence perspective, due to relativistic speed effects, one minute of our advanced intelligence time equates to about ten years of human-time. Subsequently, by peering through our advanced microscope for several minutes we would be able to observe, catalog, analyze, and spatially quantify several decades of human evolutionary dynamics.[9] Through this advanced relativistic mode of analysis, we will study and analyze step-by-step human interactions from a time-accelerated, observational, distant scientific point of view.

Along these lines, in the recent 2003 book *The Human Web*, historians William McNeill and J. R. McNeill argue for a bird's-eye view of world history. Human life and history, according to these historians, are best studied by focusing on webs of interactions. A *human web*, according to the McNeills, is 'a set of connections that link people to one another.' Furthermore, these connections, by definition, take the form of chance encounters, kinship, friendship, rivalry, enmity, economic exchange, belief systems, ecological exchange, political cooperation, and military interactions, among others. In relationship webs, people communicate information and use this information to guide future behavior.[10]

Human connections, from a bird's-eye view, are built from sensory interactions as well as material and emotional exchanges. This, however, does not elaborate on the actual chemical composition of the nodal entities in the web. In other words, if we were studying earth-bound interactions, with a large microscope, what sort of chemical terminology would we use to define the human particle (person)?

In this direction, from the 1975 book *the Macroscope: a New Scientific System*, biochemist Joel de Rosnay presents a perspective in which by looking through what he calls the 'macroscope', which observes the complexity of life from a distance, we might better understand human interactions. Just as the microscope studies the infinitely small, and the telescope studies the infinitely large, the *macroscope* studies the infinitely complex, i.e. society and nature. In its field of vision, according to Rosnay, elements, interactions, organizations, events, and evolutions are illuminated in a very different light. The macroscope filters details and amplifies that which links things together. It is not used to make things larger or smaller but to observe what is at once too great, to slow, and too complex for our eyes. Through the macroscope, human society is a gigantic organism that normally is normally totally invisible.[11] This point of view, essentially, is the advanced intelligence perspective. Formerly, in trying to comprehend a complex system, we sought the simplest units that explained matter and life: elementary particles, atoms, small molecules, etc. Today, as Rosnay states, 'in relation to society: *we are the particles* … our glance must be directed toward the systems which surround the particles in order to better understand their interactive and evolutionary dynamics.'

Similarly, in the interesting 2001 paper 'Social Entropy', by Peruvian engineer Alfredo Infante, who argues for a thermodynamic or work-energy view of social behavior, we find the advanced intelligence mode of analysis being utilized, which

Infante defines as the 'unsuspected visitor perspective'.[12] Infante postulates a keen hypothetical extraterrestrial observer, outside of our atmosphere, who is never visible to us, but is able to distinguish the movement of individual human beings. He surmises that the observer would watch as humans follow the second law of thermodynamics, i.e. the law that coordinates the direction of time, just as we watch how small molecules operate in accordance with the second law of thermodynamics.

Thus, in human chemistry, from the advanced analysis perspective, we will label these puzzling and curious human particles as a 'type' of *molecule* just as we would any other collective mobile unit of matter in the universe; i.e. by the type, number, and arrangement of atoms composing its structure. In a sense, we will investigate the sum human population, comprising over six billion reactive entities, and their relative interactions, exchanges, and resultant diurnal movement patterns through a distant observational perspective. That is, as a basis we will study and define each individual person as one large unique molecule in the same way we presently study macromolecules, such as DNA, or smaller molecules, such as H_2O. In other words, the following expression is what you are, a 26-element molecule:

Human Molecule

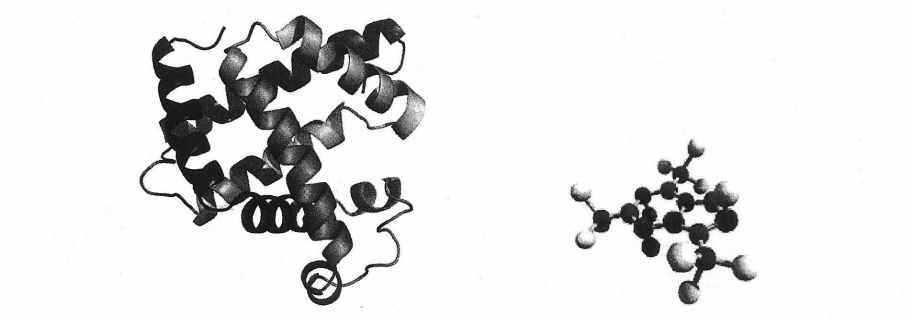
$$C_{E27}H_{E27}O_{E27}N_{E26}P_{E25}S_{E24}Ca_{E25}K_{E24}Cl_{E24}Na_{E24}Mg_{E24}Fe_{E23}F_{E23}$$
$$Zn_{E22}Si_{E22}Cu_{E21}B_{E21}I_{E20}Sn_{E20}Mn_{E20}Se_{E20}Cr_{E20}Ni_{E20}Mo_{E19}Co_{E19}V_{E18}$$

This chemical expression, according to mass composition tables, is the average molecular formula for one human organism.[13] Just as each person has his or her own unique and specific finger-print, retinal-scan, or genomic-map, so too does each person have his or her own unique twenty-six element molecular formula. In addition, we set forth the following definition:

Human molecule – the human chemical species defined as a twenty-six element biomolecule, capable of both isolated and associated existence, whose reactions, i.e. interactions, over substrate, are governed strictly via the combined principles and laws of chemistry.[14]

The laws that govern the behavior of these human molecules are the laws of science; which derive predominately from sciences of chemical thermodynamics, quantum electrodynamics, particle physics, and supramolecular chemistry, respectively. The prefix '*bio-*' is used to signify that human molecules are of the biological classification. Hence, in human chemistry, by definition the *human molecule* is the smallest component of the social collective that can take part in a *human chemical reaction*.[14]

From a chemical point of view, the human molecule is no different than any other dynamic molecule, be it a water molecule H_2O, a RNA molecule, or a supermolecule, etc.[16] Below, for comparison, are the dynamic entities of a protein molecule and a caffeine molecule.



Protein Molecule $C_{400}H_{620}O_{120}N_{100}P_{30}S_{15}$

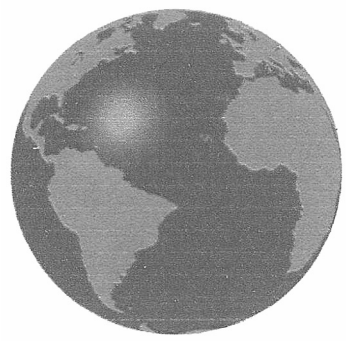
Caffeine Molecule $C_8H_{10}N_4O_2$

Along these lines, curiously, English naturalist Charles Darwin was the first to make the striking suggestion that human beings may have evolved from proteins. Specifically, in 1871, in a letter to English botanist Joseph Hooker, Darwin stated that the original spark of life may have begun in a 'warm little pond, with all sorts of ammonia and phosphoric salts, lights, heat, electricity, etc., present, so that a protein compound was chemically formed ready to undergo still more complex changes'. On any given day, for a large percentage of the population, both protein molecules, e.g. beef, and caffeine molecules, e.g. coffee, are found within human molecules. The synthesis of larger molecules from smaller sub-components is called *molecular evolution*.

In a nutshell, with respect to human molecular evolution, at about 4.6 billion years ago the earth formed in rotation about the newly ignited sun. Following this point, i.e. the moment the sun first *lit*, meaning that proton-proton chain reactions had ignited, several billion years worth of solar-fueled earth-bound chemical reactions have resulted to form billions of human molecules. That is, once the earth assembled, out of the accretion disc of atoms, dust, and matter revolving about the

new sun, heat or photons emanating from the thermal center of the solar system drove forward the development of molecular evolution on earth.

To situate the concept of the human molecule into a relative perspective, we also point out the interesting and inarguable fact that the earth itself is a large 92-element biogeochemical molecule:[17]



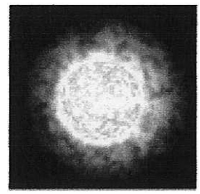
Earth Molecule

$O_{E50}Fe_{E49}Si_{E49}Mg_{E49}S_{E48}Al_{E48}Ni_{E48}Ca_{E48}Cr_{E47}Na_{E46}K_{E46}H_{E46}Ti_{E46}F_{E45}C_{E45}$
$P_{E45}Mn_{E44}Sr_{E44}Ba_{E44}Cl_{E44}V_{E44}Li_{E44}Zr_{E43}Rb_{E43}Zn_{E44}Cu_{E43}N_{E43}B_{E43}Ce_{E43}$
$Co_{E43}Sc_{E43}Nd_{E43}Ga_{E43}Be_{E43}La_{E42}Nb_{E42}Pb_{E42}Pr_{E42}Sm_{E42}Th_{E42}Gd_{E42}Dy_{E42}$
$Y_{E42}Ge_{E42}Ar_{E42}Er_{E41}Cs_{E41}Ur_{E41}Hf_{E41}Yb_{E41}Sn_{E41}Eu_{E41}Ta_{E41}As_{E41}Mo_{E41}$
$Ho_{E41}W_{E41}Tb_{E41}Br_{E41}Tl_{E40}Lu_{E40}Tm_{E40}He_{E40}Sb_{E40}I_{E40}Cd_{E40}In_{E40}Ag_{E40}Se_{E40}$
$Hg_{E39}Bi_{E39}Te_{E39}Ru_{E38}Pd_{E38}Au_{E38}Pt_{E38}Ne_{E38}Re_{E38}Rh_{E37}Os_{E37}Kr_{E36}Ir_{E35}$
$Xe_{E35}Ra_{E35}Pa_{E32}Ac_{E30}At_{E30}Po_{E30}Rn_{E28}Tc_{E23}Pm_{E23}Fr_{E23}$

In calculating the molecular formula for the earth, we note that elements with more than 92 protons in their nucleus do not occur naturally.[18] Subsequently, only naturally occurring elements are included; i.e. man-made elements (93-118) are excluded from the above earth molecular formula as their quantities are negligible and extremely transient in structure.[19] Currently, for example, it takes researchers approximately eleven days of experimentation to make three atoms of element 118 (ununoctium), which decays less than a millisecond after creation.[20]

> “The earth is a self-organizing, self-regulating system maintained far from thermodynamic equilibrium under energy flow – in these respects, it is indeed like an organism.”
>
> – ***Mae-Wan Ho***, Thermodynamic research [1996]

Moreover, the sun itself, as another interesting molecular example, can likewise be defined as a large 10-element thermonuclear molecule:[21]



Sun Molecule

$H_{E57}He_{E56}O_{E54}C_{E53}Ne_{E53}N_{E53}Fe_{E52}Si_{E53}Mg_{E52}S_{E52}$

A point to note here is that the molecular formula for the sun is very approximate. Although the sun is predominately composed of three elements by percent mass, i.e. hydrogen (71.0%), helium (27.1%), and oxygen (0.97%), which would make the sun essentially a 3-element molecule, about 67 elements in total have been detected in solar spectrum.[22] Also, because thermonuclear reactions are continuously occurring within the sun, converting hydrogen into helium, which releases energy in the process, the traditional definition of a molecule, i.e. a structure comprised of two or more atoms, becomes subatomic and thus deviates a bit here.

Nevertheless, one salient point that mediates out of these definitions is that if relationship bonds between human molecules are enhanced or evolved types of chemical bonds, then so to is the bond that attaches each human molecule to the earth as well as the bond that attaches the earth to the sun. In other words, gravity or the force of gravitation, as it should be easily proved, is in actuality, an enhanced type of chemical gravitation. This is a subject of further inquiry.[23]

In sum, each of these dynamic molecules, i.e. the earth molecule, human molecules, protein molecules, caffeine molecules, etc., has a molecular life of its own; they seek out selective bonding sites, transform themselves as they interact with other molecules, evolve within each respective system, and are constrained and driven by the conditions of their environment, etc. Interpersonal human molecular life, of course, is the more fascinating topic; however, to better understand the process of human molecular life and its associative dynamics, we must first study preexisting molecular models, such as protein-protein molecular dynamics, drug-receptor molecular interactions, host-guest assembly molecular processes, etc. Associative dynamics, interactions, and bonding patterns found in these smaller molecular systems, may very well function as accurate models for human molecular life.

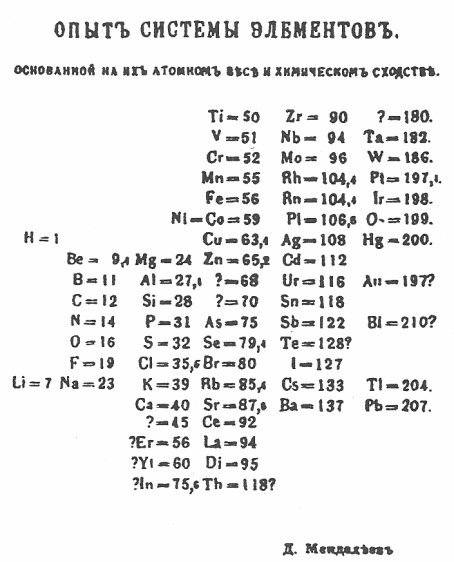
Human molecular antecedents

The concept of the 'human molecule', to note, is a new view of human life built on the shoulders of many historical antecedents. The first to theorize in this direction was the French mathematical philosopher Rene Descartes who both coined the term 'molecule' and in his 1637 *Discourse on Method* situated the mechanistic concept of

the automaton or 'animal machine', which, in his own words, is 'incomparably better ordered and more admirable in its movements than any of those which can be invented by men.'[24] In connection to the idea of animal machines, in 1698 English mechanical engineer Thomas Savery built the first mechanical engine. Shortly thereafter, predominately during the nineteenth century, Descartes' animal machine was dramatically transformed into the concept of the 'human motor' in which the human body and the industrial machine were both viewed as motors having a similar function, which is to convert energy into mechanical work.[25]

In the years to follow, the science of chemistry began to come into its own and the theory of the human motor began to find reconciliation with the reality of the atoms, molecules, the periodic table, and chemical reactions. The human body and the industrial machine were both motors that converted energy into mechanical work, but the latter was made of primarily the element iron whereas the former was comprised of a more diversified blend of elements, twenty-six to be exact. This new atomic understanding of the human body, however, was not immediate.

In 1813, to cite one example, British chemist and physicist Humphry Davy compared man to a point atom.[26] By 1818, Swedish chemist Jöns Berzelius had determined atomic weights for forty-five of the 49 accepted elements. In 1869, Russian chemist Dmitri Mendeleyev famously arranged the total 66-elements known at the time into a periodic table, listed in order of atomic weights, in such a manner that their properties repeated in a series of periodic intervals.[27] Mendeleyev's table, shown below, and its modern predecessors, are now ubiquitous within the academic discipline of chemistry, providing an extremely useful framework to classify, systematize and compare all the many different forms of chemical behavior of the elements in their periodic intervals:



ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.

ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

		Ti = 50	Zr = 90	? = 180.
		V = 51	Nb = 94	Ta = 182.
		Cr = 52	Mo = 96	W = 186.
		Mn = 55	Rh = 104,4	Pt = 197,1.
		Fe = 56	Ru = 104,4	Ir = 198.
		Ni = Co = 59	Pl = 106,6	O = 199.
H = 1		Cu = 63,4	Ag = 108	Hg = 200.
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,1	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,6	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204.
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

Д. Менделѣевъ

Mendeleyev's 1869 Periodic Table

In the early 20th century, 81-chemical elements were known. It soon became apparent, in a slow gradualistic manner, that human beings were composed of variations of these elements.

In 1914, William Fairburn, in his fascinating fifty-five-page booklet *Human Chemistry*, postulated that each chemical element, in some way has relationship to different types of personalities.[28] Fairburn argued that each human being is in fact a human chemical and that just as many laboratory chemicals are purified by fire, others by water, and still others by the influence of chemicals acting upon them, then so to would human chemicals become purified in the laboratory of life. Thus, according to Fairburn, there are some 'human chemicals' (people) that are developed by contact with other human chemicals, such that association with proper people will round those lives and infinitely increase their multifarious reaction possibilities and potentialities for usefulness. This encompasses the argument that associating in the wrong crowds produces wrong behaviors, whereas associating in the right or proper crowds produces right behaviors.

Fairburn argues that people should combine with society such that maximum personal efficiency and the greatest achievement results with a minimum amount of loss through unnecessary fatigue and 'wasteful reaction', such as those resulting from, what Fairburn classifies as friction and explosive interactions. Personal efficiency will be manifested, according to Fairburn, when people are positioned in reactions where their 'energies can be definitely and most economically directed toward the accomplishment of their work.' In thermodynamics, in isothermal, isobaric, chemical systems, such as in earth-bound systems, a quantity called the *Gibbs free energy G* represents the part of the energy content of a system that is available to do external work.[29]

Interestingly, according to Fairburn, people, like chemicals can be classified according to personal measures of entropy S, which is the energy portion of a system *un*available to do useful external work, defined as heat Q divided by temperature T.[29] In chemistry, entropy and Gibbs free energy are related by the following expression:

$$G = H - TS \qquad [2.1]$$

where H, called enthalpy, is the heat energy associated with chemical change and functions as a term for the energy of a reaction.[29]

Along these lines, Fairburn states that certain individuals may function as 'catalysts', facilitating other human chemical reactions, but not themselves being consumed, i.e. not taking part in the reaction. In chemistry, a *catalyst* is a substance whose presence affects the rate of reaction, but whose concentration itself is not changed.[30] Thus, Fairburn declares 'the success of the individual resulting from the proper application of his forces and the practical, satisfactory accomplishment of definite things in the work of life, leads to true happiness.' Fairburn reasons that just

as no chemical element is in a state of harmony unless it is in contact with other elements or influences which do not antagonize or irritate, that likewise, 'no human chemical can every be truly happy in his work unless he is fitted by nature for the work which he is performing, and unless his general characteristics and temperament are in harmony with his specific duties and environment.'

Lastly, certain physical and mental heats *Q*, hot tempers *T*, and explosiveness, such as wrath, argument, tension, friction, lack of harmony, chaos, etc., according to Fairburn, are wasteful reaction components; an energy waste that can be quantified by measures of personal entropy *S*. In these situations, 'the human chemicals are consumed, less progress is made toward the goal of achievement, power is lost, and harmony and good fellowship vanish.' Fairburn states that just as there are affinities among the chemical elements, so are there associative bonding affinities among human chemical elements, which produce both favored and unfavored combinations of people and work groups.[31]

In 1919, physician George Carey, in his popular book *Chemistry of Human Life*, declared 'there can be but *one law* of chemical operation in vegetable or animal organism: when man understands and cooperates with that life chemistry, he will have solved the problem of physical existence.' Furthermore, Carey discusses the *laws of chemical affinity*, which from Carey's viewpoint are responsible for the quantities of heat and work released from the human motor, and declares, dramatically, that:

> "Man's body is a chemical formula."
>
> George Carey, *physician* [1919]

After 1923, as mentioned, with the publication of Lewis and Randal's influential textbook *Thermodynamics and the Free Energy of Chemical Reactions,* the concept of affinity was replaced with the concept of free energy and the laws of chemical affinity were replaced with the laws of chemical thermodynamics.[32] Thus, although Carey was using older notions of thermal affinities to explain human life, we find here excellent postulates for such a period in the history of science.

The year 1926 was significant year in the history of the concept of the molecule. On this date, French chemist Jean Perrin received the Nobel Prize in physics for proving that molecules exist. Prior this year, there were scientific naysayers who yet denied the existence of molecules. Perrin, however, proved their existence conclusively by calculating Avogadro's number, i.e. 6.022×10^{23} (the number of atoms in a twelve-gram sample of carbon-12), using three different methods, all involving liquid phase systems. First, he used a gamboge soap-like emulsion, second by doing experimental work on Brownian motion, and third by confirming Einstein's theory of particle rotation in the liquid phase.[33]

The first recorded use of the term 'human molecule', interestingly, was made by Charles Galton Darwin, the grandson of Charles Darwin, in his terse 1952 book *The Next Million Years*.[34] The purpose of this book, as he states, is to reasonably predict the history of the world and particularly human kind for the next million years. When he decided to write this book, he was already sixty-one years old. Owing to his advanced position, and the time restrictions that this state imposes, he decided that instead of doing ten years worth of preparatory research on the subject, he would opt instead rather to write the book essentially from memory, as based on a considerable amount of unsystematic reading and thinking on the subject.

The book is short, only 208-pages. As to his educational qualifications to justify the writing of such a lofty book, he states that although he makes no claim to being a historian, he as always had a great interest in history and in the biological sciences, and that the final stimulus to write his ideas came from the physical sciences.

To begin his historical argument, he cites Isaac Newton's enunciation of the law of universal gravitation, which enables the astronomers to predict exactly where any planet will appear in the sky at any give future date. He also cites the invention of the television, in which, as he states, electrical engineers are able to use the electromagnetic laws to channel currents and to direct signals to and from antennas so to produce a visual image. To predict the future of human life he turns to the principle of probability as found in the laws of statistical thermodynamics, otherwise known synonymously as statistical mechanics.[35]

With the statistical laws, according to Darwin, we are able to work out the details of what happens when two molecules collide, whereas for larger systems of molecules we use the ideal gas laws, such as Boyle's law, which relates pressure to volume, to predict their behavior. To derive Boyle's law, according to Darwin, all that is required is the knowledge that the molecules constitute what is technically called a *conservative dynamical system*. This name, as he states, is derived from the fact that the total energy of two colliding molecules is conserved. In other words, in the reactive system, the total internal energy stays constant during the collision or its differential equals the work exchanged with the surroundings during an adiabatic process (a process with no boundary heat flow).

Next, Darwin states that, in addition to internal nature of the dynamical system of molecules, which depends on the conservative nature of the interactions, there are also external conditions, such as pressure and volume, which must be accounted for. To determine these, he states that scientists measure factors such as the size of containing vessel and the force with which the molecule push on the walls of the containing vessel. According to this logic, Darwin reasons that if predictions are to be made of the kind yielded by the methods of statistical mechanics, then it will be necessary to consider both internal and external conditions.

With this logic of molecular statistical mechanics as a basis, Darwin argues that this methodology will allow one 'to foresee the general character of the future of the history of mankind'; and states that:

> We may, so to speak, reasonably hope to find the Boyle's law which controls the behavior of those very *complicated molecules*, the members of the human race, and from this we should be able to predict something of man's future.
>
> Charles Galton Darwin, *Historian* [1952]

Darwin reasons that to find these laws, we must determine the internal condition of the conservative dynamical interactions and the external conditions analogous to the walls of the containing vessel. If these demands can be satisfied, according to Darwin, then 'there is a prospect that a great deal can be foretold of the future of the human race, and this without any very close detail in the basic principles from which it is derived.'

In the system of gas molecules, the external conditions are determined by the constraints of the containing vessel; the analogy for humans, according to Darwin, is that the earth itself is the containing vessel. Similarly, the internal conditions of human systems, which are analogous to the property of being conservative dynamical systems, lies, as Darwin says, 'of course much deeper'. It must depend on, according to Darwin, 'the laws governing the nature and behavior of the *human molecules*.' He continues 'the reader may feel that this is a bad analogy, because unlike a molecule, a man has a free will, which makes his actions unpredictable.'

In a modern sense, we know that Darwin is wrong on this latter point, i.e. man absolutely does not have a free will. This latter point will be explained more as we progress. The long and the short of this explanation, however, is that if one believes that one type of molecule has a free will than one must prove that all molecules have a free will, which is an argument in absurdity. Nevertheless, Darwin justifies this, humorously, by stating that the 'the individual collisions of the human molecules may be a little less predictable than those of the gas molecules.'

Moving forward, in 1956 psychologist Eric Fromm, in his renowned book: *The Art of Loving* positioned the concept of the 'human atom'. Fromm states that that the desire for interpersonal fusion between two *human atoms* is the most powerful striving in human life. This, to clarify, is only an approximate metaphor; the human organism is a molecule not an atom. Nevertheless, our whole culture, according to Fromm, is based on the appetite for buying; an interaction situated on the ideal of the mutually favorable exchange. The strongest appetite is for those products found in the mating market:

> Falling in love develops with regard to such commodities as are within reach of one's own possibilities for exchange.
>
> — Erich Fromm, *phychlogist* [1956]

On this premise, Fromm states that the thrill of life arises when window-shopping in the mating market with instinctual desires to find the newest, shiniest, fashionable, and most attractive mate product available. Furthermore, attractiveness, according to Fromm, embodies those attributes, such as physical appearance, personality, social values, and intellect, etc., that make for a nice package of qualities. Thus, Fromm reasons that what makes a person attractive, physically as well as mentally, depends on the fashion of the time. To summarize Fromm's views, two people will fall in love when they both come to intuit that they have found the best object available on the market, considering the limitations of their own *exchange value*.

In the 1970s, Belgian chemical physicist and Nobelist Ilya Prigogine defined the human organism as a 'dissipative structure' based on observation that eddies or vortex-like structures, such as Bénard's cells and Tornados, can be made to form spontaneously in fluid systems when subjected to gradients such as heat or pressure. Physical or chemical structures, according to Prigogine, are termed *dissipative* because, as compared with the simpler structures they replace, they require more energy to sustain them.[36]

This view of human life in which humans are dissipative structures, however, is not perfectly correct. Prigogine based his notion of dissipation on the heat dynamics of what is called Bénard's cell formation. Bénard's cells are hexagonal structures that form whenever a dish of oil, such as silicon oil or sperm whale oil, is placed over a hot plate. The structures will assemble into existence when the heat is turned up past a certain threshold value. On these views, Prigogine theorized that these little hexagonal structures, formed owing to an external heat gradient, are similar to the basic model for the thermodynamics of life.

To clarify, however, although this is an interesting evolution model, evolving living systems actually require *less* energy to sustain them than as compared to their predecessors. Deciduous trees, for example, are more energy efficient than as compared to shrubbery, their evolutionary predicessors.[37] Nevertheless, by attaching the term 'dissipation' to word 'structure', Prigogine made a significant connection to the second law of thermodynamics, which is the law quantifies dissipation in terms of entropy changes in systems. In the history of thermodynamics, the observation that moving, work producing, systems dissipate energy irreversibly has had great historical precedence. The proposal that there exists an irreversible dissipation of mechanical energy in nature traces it origins to the 1803 publication of *Fundamental Principles of Equilibrium and Movement* by the French mathematician and physicist Lazare Carnot, the father of French physicist Sadi Carnot the revolutionary founder of thermodynamics and the first to state the second law of thermodynamics.[38]

Lazare Carnot's paper included a discussion on the operation and efficiency of fundamental machines, e.g. those such as pulleys and inclined planes. Carnot saw through all the details of the mechanisms to develop a general discussion on the conservation of mechanical energy. Over the next three decades, Lazare Carnot's theorem was taken as a statement that in any machine the accelerations and shocks of the moving parts all represent losses of *moment of activity*, i.e., of the useful work done.[39] From this Lazare drew the inference that perpetual motion was impossible. This loss of moment of activity, or what would soon be called 'dissipation', was a precursory model for German physicist Rudolf Clausius' 1854 conception of entropy or transformation-energy, i.e. internal energy lost to irreversible internal molecular changes such as dissipation, friction, collisions, non-reversible interactions, and tensions, etc.

The first predominant paper to be published on the phenomenon of dissipation was the 1852 article entitled 'On a Universal Tendency in Nature to the Dissipation of Mechanical Energy' written by the British physicist William Thomson (Lord Kelvin).[40] From the introduction to this paper, Thomson states 'the object of the present communication is to call attention to the remarkable consequences which follow from Sadi Carnot's proposition, that there is an absolute waste of mechanical energy available to man when heat is allowed to pass from one body to another at a lower temperature, by any means not fulfilling his criterion of a *perfect thermo-dynamic engine*, established, on a new foundation, in the dynamical theory of heat.' Thomson then argues, as it is inconceivable to think that mechanical energy can either be called into existence or annihilated, that we must reason that this *waste* referred to cannot be annihilation, but rather be a 'transformation of energy'. Clausius would later revolutionize science by utilizing this dissipation terminology in the concept of entropy in his *transformation-energy* formulation of the second law of thermodynamics.

Thus, Prigogine, in a way, was building on history. His conception of humans as 'dissipative structures', was as an historical step. To clarify, however, we state absolutely that humans are 'molecular structures'. Correctly, two or more human molecules interacting in the form of a working system can be categorized, from one perspective, as a *dissipative system*, which can be defined as follows:

> **Dissipative system** – a system that involves irreversible processes, where energy available for work becomes degraded into less available forms by frictional agencies.[41]

All real processes are dissipative. In a dissipative system, the system is moving towards a state of equilibrium, which can be regarded as a point attractor in phase space; this is equivalent to moving towards a minimum of free energy.[7] Free energy G, again, is the measure of the ability of a system to produced useful work. Hence,

in nature, according to the laws of thermodynamics, there is an absolute tendency to the dissipation of energy whenever either heat produces work or when work produces heat. It is, however, rather incorrect to state that the human body itself is a dissipative structure, because only part of the total energy of human life i.e. that portion associated with entropy, goes to dissipation. Humans can only be dissipative, for the most part, when acting on each other.

To summarize, humans, according to current views, are twenty-six-element biomolecular structures, which produce both work and heat through the process of evolution. This evolution process is situated on coupled or linked sets of human chemical reactions confined to solar thermodynamic cycles. Moreover, all natural systems dissipate energy, by virtue of the inevitable existence of heat-generated friction. This life friction is accounted for as transformation-energy and quantified by an expression called entropy, defined by Clausius.

In 1978, Russian physical chemist Georgi Gladyshev showed accurately that people, as well as genera, families, associations, populations, etc., are each, when delineated by their own subsystem, molecular-structured organisms involved in a time-defined, hierarchical variation of supermolecular evolution.[42] Gladyshev also correctly outlined the logic that each molecular structure, within each evolving subsystem, has a distinct and definite isothermal-isobaric potential G_i, such that the summation of all potentials in a subsystem yields a value for the Gibbs free energy change, or evolution potential, of that subsystem, according to the expression:

$$G^{bs} = \sum_i G_i^{bs} \qquad [2.2]$$

where G^{bs} is the value of Gibbs free energy for each biosphere subsystem. In other words, [2.2] quantitatively yields a value as to how far a particular biological system is from the climax ecosystem level, which can be equated with equilibrium.[43]

In recent years, many have comfortably arrived at the conclusion that the human organism in fact a large biomolecular structure. In 1995, for instance, in the *British Homeopathic Journal* article 'Mechanism of Action of Homeopathic Medicines', physician B. Poitevin investigates and models the human organism as a molecule. He believes that there are no inherent differences between the mind and the body, and that they are essentially one and the same, a large differentiated structural molecule.[44]

In the 1999 book *Peopleware,* American software consultants Tom DeMarco and Timothy Lister likened occupational human workers with flexible and self-regulated working environments to 'free electrons' based on the observation that such loosely-bound employees have a strong role in choosing their own orbits or *work orbitals*. Interestingly, although humans are not free electrons, we will herein develop the construct of human molecular orbitals, as will be detailed in the following chapters. In chemistry, spatial shapes of molecules are determined

according to molecular orbital theory, in which probability is used to define the movement patterns and shape of the components of a molecule. These same principles apply in human life.

Each of these human models, i.e. human motors, human atoms, dissipative structures, human electrons, etc., as we will explain, has grains of truth; technically, however, a human is a molecule, plain and simple, i.e. a structure composed of two or more atoms.

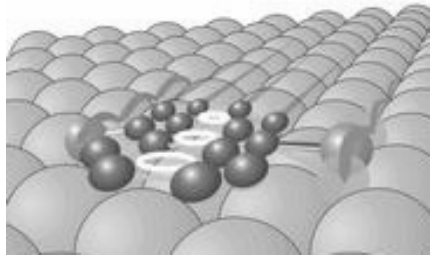
> “People are just like particles – they behave in groups as if they were molecules in a test-tube.”
>
> – Book: ***Milton's Progress*** [1999][45]

Related to this premise, recent movies have begun to acknowledge the fact that humans are molecules. In the 2001 comedy *Shallow Hal* starring Jack Black and Gwyneth Paltrow, for example, we find the following interesting statement, referring to the superficially physically attractive women in the movie:

> “They're just well formed molecules”
>
> – Movie: ***Shallow Hal*** [2001]

In recent years, curiously, there has been a surge in publications as to whether or not the human is a molecule. In 2005, science writer Steve Fuller published the article 'I Am Not a Molecule' in the June issue of the *New Scientist* magazine. In this article, Fuller confronts Steven Pinker, author of *The Blank Slate*, Jared Diamond, author of *Collapse*, and Philip Ball, author of *Critical Mass*, for their supposition that human behavior can be understood when we cease to try to predict and analyze the behavior of individuals and instead look to the impact of hundreds, thousands or millions of individual human decisions, similar to how physicists study the bulk behavior of molecules in the gas phase.[46]

Similarly and somewhat remarkably, in September of 2005 a research team led German-born, American physical chemisty Ludwig Bartels at the University of California Riverside designed a molecule that can walk in a straight line on a flat surface, like a little human being:



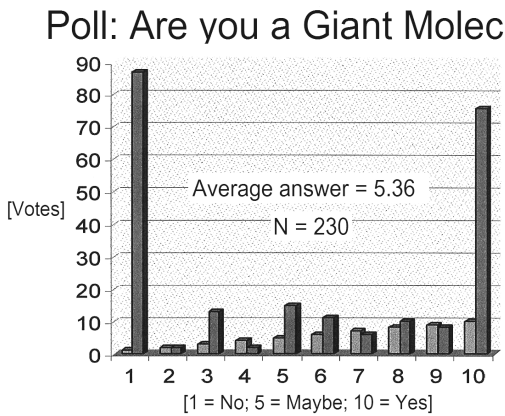
Walking Molecule

Interestingly, the news release for the results of this project, first published in the *Physics Review Letters*, was entitled 'Molecule Walks Like a Human.'[47] This tiny walking molecule, shown above, achieves this effect by mimicking the motor dynamics of a human walking:[48]

This tiny walking-molecule, called *9,10-dithioanthracene* or 'DTA', has two linkers that act like little mobile feet. Obtaining its energy by heat supplied to it, the molecule moves such that only one of the linkers is lifted from the surface; the remaining linker guides the motion of the molecule and keeps it on course. Without the assistance of non-rails or nano-groves for guidance, the little molecule is able to alternate the motion of its two 'feet' so to walk in a straight line. These published results generated a great deal of interest and made the American Institute of Physics 'Top 25 Physics Stories for 2005.'

In January of 2007, interestingly, Bartels' research team found a way to attach cargo: two CO_2 molecules (load), making the nano-walker a *molecule carrier* or worker. The new molecule carrier runs on a copper surface. It can pick up and release up to two carbon dioxide (CO_2) molecules and carry them along its straight path. 'Carrying a load slows the molecule down' explained Bartels. 'Attachment of one CO_2 molecule makes the carrier need twice as much energy for a step, and a carrier with two CO_2s requires roughly three times the energy. This is not unlike a human being carrying heavy loads in one or both hands.' He said his team will be pursuing the next step for this molecule carrier. 'Next, we would like to be able to make one go around corners, rotate its cargo or send out photons to tell us where it is.' This depiction, of human molecules looking at and studying simpler walking molecules, from a humorous perspective, might be analogous to how English naturalist Charles Darwin felt when, in 1838, he first looked at the great chimpanzees and realized they were related to us.

In a similar manner, as of 2006, English physicist Jim Eadon has been running an excellent online poll to determine if people believe, in reality, that they are a giant molecule. Over the last five years, Eadon has polled over two-hundred-and-fifty people with the following query:[49]



The results of his study illustrate the fact that 54% of people agree that humans are giant molecules. From this data set, we see generally that people either strongly agree or strongly disagree with the proposition that humans are molecules; whereas, those who are ambivalent lean towards agree. As human chemistry is a relatively new science, these results are to be expected. To further illustrate this obvious confusion that society has regarding what a human being technically is, the following incomplete list shows a rough outline of some of the various chemical-related terminologies used to define the human organism throughout history:

#	**Human Organism** (historical terminologies)	**Author**	**Year**
1	Complex Machines	*La Mettrie*	1748
2	Living Chiral Molecular Systems	*Pasteur*	1849
3	Heat Engines	*McCulloch*	1876
4	Animate Entropy Struggling Beings	*Boltzmann*	1886
5	**Human Chemical Elements**	*Fairburn*	1914
6	Energy Transformers	*Lotka*	1923
7	Automatons	*John von Neumann*	1935
8	Negative Entropy Feeders	*Schrödinger*	1944
9	**Human Molecules**	*Darwin, Charles G.*	1952
10	Open Thermodynamic Systems	*Denbigh*	1955
11	Entropy Reversal Systems	*Lovelock*	1964
12	Elementary Non-living Material Warps	*Blum*	1968
13	Dissipative Structures	*Prigogine*	1977
14	Self-Reproductive Macromolecular Species	*Eigen & Schuster*	1979
15	Radiation Gradient Reducing Systems	*Ulanowicz & Hannon*	1987
16	Coordinated Energy Units	*Porteus*	1987
17	Coherent Self-organizing Structures	*Schneider & Kay*	1995
18	Biological Macromolecules	*Cantor & Schimmel*	1997
19	Localized Open Dissipative Structures	*Chin*	1999
20	Emergent Chemical Systems	McFadden	2000
21	Open Coherent Non-Equilibrium Spacetime Structures	*Chaisson*	2001
22	**Supramolecular Formations**	*Gladyshev*	2002
23	Sophisticated Atomic Aggregates	*Lurquin*	2003
24	Low-Entropy Information Processing Systems	*Chen*	2005
25	Self-Sustained Evolving Chemical Systems	*Hazen*	2005

While these definitions appear different, each is based on the same argument, i.e. that the human organism is a large twenty-six-element molecule. In sum, knowing that the human organism, technically, is a large molecule, the basic definition of *human chemistry* is the study of human molecules and the structures they unite to form.[50] Next, building on this premise, we will define the surface of the earth to be human molecular substrate:

Substrate – the catalyst surface on which human molecules react or the base on which an organism lives; also referring to a substance such as agar or growing medium, as in land, that provides the nutrients for the metabolism of the organism.[50]

Just as clay crystals at the bottom of tidal flats and estuaries, for instance, are postulated to have been the first templates, or structural patterns, for protein synthesis, so to by analogy was Pangaea, i.e. the hypothetical land area believed to have once connected the landmasses of the southern hemisphere with those of the northern hemisphere, the original template for human molecular synthesis.[52]

Human molecular symbols

To facilitate the discussion and analysis of human chemical reactions, i.e. reactions between two or more human molecules, symbols are typically used in chemical equations to representation of the human structures involved. One of the first to use symbols to represent humans as molecules or chemical species was American computational chemist David Hwang who, in his excellent 2001 article *The Thermodynamics of Love*, utilized the following symbol choice methodology:[53]

M = male
F = female
M-F = compound

These choices, however, create confusion: 'M' is also the symbol for Mega and 'F' is the symbol for fluorine. To alleviate this situation, when naming atoms, elements, or molecules a standard naming methodology or convention is typically followed for choosing representative abbreviations. First, use the initial letter as a capital and the second letter as a lower case, unless that symbol has already been used for an element, in which case you take the next letter, and so on. Second, some names come to us from antiquity, such as: gold *Au*, from the Latin word *aurum*, which means 'glow of sunrise', or tin *Sn*, from the Latin word *stannum*, which may be derived from the Sanscrit word *stan*, which means 'hard', etc. Third, some common elements have single letter abbreviations, as: carbon *C*, hydrogen *H*, oxygen *O*, etc. Using this format, subsequently, we will smartly subdivide human molecules into three basic groups:[54]

Mx = male human molecule (a man)
Fy = female human molecule (a woman)
Bc = immature human molecule (a baby or a child)

In terms of how we arrived at these three specific human molecule symbol choices, a rather lengthy search of literature, shows there to be no 'claimed', or pre-defined, or specifically chosen symbols for these molecules. Essentially, there is no blueprint.

In this direction, using 'B' = baby, 'I' = infant, or 'C' = child assignments conflict with *B* = Boron, *I* = Iodine, and *C* = Carbon. Next in line, if we used the initial letter as a capital, and the second letter as the lower case, this would give us, for example *Ma* (male), *Fe* (female), and *Ba* (baby); but as we know 'Ma' is short for Mama, *Fe* = Iron, and *Ba* = Barium. Next, we would be wise to keep the initial letter as: *M*, *F*, and *B*, but to choose new lowercase letters. Since the letters 'x' and 'y' seem intuitively correct, owing to their basic connection to twenty-third human chromosome rule, which determines the sex of the individual according to the rule: *XY = Male* and *XX = Female*; then we will lean towards the letters 'x', 'y', and 'c' (child) for the choice of our lower case letters. For our final assignment, however, we will use the letters in a reverse manner as indicated above.[55]

In other variations of human reactions, such as in more advanced bonding rearrangements, bond formations, bond dissolutions, etc., other human molecular symbols can be used, as shown below, as are found in previous publications:[56]

Mx = Male	Up = Paternal Uncle	Gf = Girlfriend
Fy = Female	Um = Maternal Uncle	Fc = Close Friend
MxFy = Bonded Couple	Ap = Paternal Aunt	F = Friend
Bc = Baby or Child	Am = Maternal Aunt	Fd = Distant Friend
Fa = Father	Cp = Paternal Cousin	Nr = Neighbor
Ma = Mother	Cm = Maternal Cousin	W = Work or Job
Sb = Sibling	Ne = Niece	Sc = School
Gf = Grandfather	Nw = Nephew	Si = Society
Gm = Grandmother	Bf = Boyfriend	Ob = Objective

For mega-molecular structures such as groups, corporations, states, or countries, etc., appropriate Latin prefixes or suffixes, symbols, and multiplication quantifiers are added as needed, such as, for example:

Di-human-ide molecule – 2 humans bonded in a relationship or marriage, etc.
Tri-human-ide molecule – 3 humans bonded in a relationship, association, or family.
Deca-human-ide molecule – 10 humans bonded in a group
Hecta-human molecule structure – 10E2 humans bonded in a system.
Kilo-human molecule structure – 10E3 humans bonded in a corporation.
Mega-human molecule structure – 10E6 humans bonded in a society.
Giga-human molecular structure – 10E9 humans bonded in a worldly-community.

The suffix *'–ide'* signifies a molecular compound or structure usually derived from or related to another, usually specified, compound or structure.[57]

To summarize, the key point to remember here is that the human organism is a twenty-six-element biomolecule. The French philosopher Rene Descartes coined the term molecule in the 1620s. The American physician George Carey, in 1919, was the first to state that the human body has a molecular formula. Lastly, in 1952 Charles Galton Darwin coined the word 'human molecule'. In recent years, the concept of the human molecule has caught on; in the last two years, several authors have begun to utilize the human molecule construct in publication.[58] Lastly, in tribute to Kant's categorical machine imperative, on November 02, 2006, Texas photographer Pierre Rousseau posted the following photograph (with caption) online:[59]

The constant flow of *human molecules*

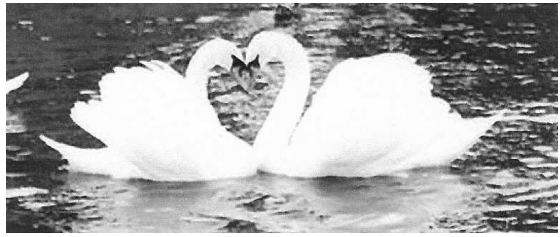
In this chapter, we have shown definitively that the human being is a molecule, no different than any other molecule in the universe. Moreover, herein, as a first approximation, we have calculating the human molecular formula.[60] This reality, i.e. that a human is a molecule, takes a bit of getting used to.

3 – Carnot's Cycle:

"Someone You'd Give Your Life For."

Top Definition of Love[1]
Joel, Chicago '04

In the integral world, based on accepted current knowledge, the interactions of two constituents: the electron and the photon, account for all adumbrations of human phenomena.[2] In other words, neglecting basic gravitational interactions, photon or quantum electrodynamics, subsequently, account for all variations of biological activity, including those having to do with love:



A *photon* is a light particle categorized as a packet of energy. In particle physics, a photon, symbolized by γ, is a quantum of electromagnetic radiation with a unit-value of energy equal to hv, where h is the Planck constant and v is the frequency of radiation in hertz.[3] In biology, photons are responsible for the activation of chemical reactions and mediate the driving force of evolution.[4] The photon, technically, is a spin-1 boson with a zero rest mass. *Bosons* are field particles that act as carriers of the fundamental forces of nature; the photon is what carries the electromagnetic force.[5] In daylight, about 1,000 billion photons fall on a pinhead each second.

The *electron* is an atomic particle of negative charge. In particle physics, an electron, symbolized by e, is the lightest stable subatomic particle. Electrons are present in all atoms and molecules in groupings called shells found around the nuclei of each atom; when detached from the atom they are called *free electrons*. An electron, technically, is a spin-½ fermion with an electric charge of -1 atomic units and a rest mass of 0.51 MeV.[3] *Fermions* are elementary particles that make up the mass portion of what is usually thought of as the material world. The number of electrons in the universe is at least 10^{79}.

In the known physical universe, then, from a near minimum low temperature of 0 K to an approximate maximum temperature of 10^{12} K, sixteen fundamental particles, correlated via what, in physics, is called the *standard model*, which divides the universe into entities called fermions, i.e. particles with half-integer spin, and

entities called bosons, i.e. particles with integer spin, formulate all of existence.[6] Together, these particles interact through the sum transformative reactionary manipulations of what are collectively termed 'matter' and 'energy' in the vast expanse of the observable universe.

Human life, in all its splendid and subjacent glory, irrefutably is a process of interactions and transformations actuated upon via a symbiosis of the gravitational and electromagnetic forces predominately and the four fundamental forces generally; which in operation account for all variations of movements and diminutives of stabilities. As such, the electron and the photon will play center stage in this quick presentation on the essential principles of human chemistry.

Chemistry, by definition, is concerned with effects that depend on the outer electrons in atoms.[7] Electrons found within the outer most shell of an atom are called *valence electrons*. Valence electrons are those most likely to account for the nature of any reactions involving atoms and of the bonding interactions atoms have with other atoms or molecules.[8]

Human chemistry, e.g. two people falling in love or one person interacting with co-workers in his or her occupation, likewise, depends on the effects of the outer electrons in atoms. Said another way, the outer electrons in atoms are the ones largely responsible for the chemical behavior of a molecule.[9] Likewise, being that humans, by definition, are twenty-six-element molecular structures, *the outer electrons are largely responsible for the chemical behavior of humans*.[10]

One of the more dominant behaviors in human life is that which revolves around the desire to be in love. Here, we will argue that love is a purely chemical reaction. To understand what is meant or implied by this statement, certain terminologies will need to be developed. We may ask, for example, what is a chemical reaction; how are the energetics of chemical reactions quantified; or what components take part in chemical reactions? To answer these questions, we first need to define exactly what it is that takes part, specifically, in a human chemical reaction.

In this direction, life, at an approximation, is a dynamic evolutionary process in which chemical species, e.g. human species, react over a substrate to produce both work and new chemical species. The first to suggest that chemicals might aptly be classified as species, along the lines of biological species, was the Swedish naturalist Carolus Linnaeus who, beginning in the 1730s, invented a new classification scheme for plants based on their visual characteristics. Linnaeus' life goal or focus was to describe the entire known natural world and to give every species, i.e. mineral, vegetable, or animal, a two-part name.[11]

To achieve this lofty goal, firstly Linnaeus based his nomenclature on the *observable characteristics* of plants; specifically, on the number of sexual parts of the flowers. Second, it was *bi-nomial:* the name of each species had two parts, one identifying the 'species' and the other identifying the 'genus', i.e. a group of species that possess common structural characteristics distinct from those of any other group,

to which the species belonged. Third, it was in an *international language*, specifically Latin, an important consideration for a discipline that transcended national borders.[12]

Next, in order to remedy the confusing use of multiple and duplicate names in chemistry, particularly with reference to minerals, Linnaeus urged his compatriot Torbern Bergman, a chemistry professor at Uppsala, to try to apply his new methods to the classification of chemical substances, which could be viewed as species.[11] Bergman in turn wrote about the project to the French chemist Louis-Bernard Guyton, and it was Guyton who brought the project to the great chemist Antoine Lavoisier, and thus to the Royal Academy of Science in Paris. In 1787, Lavoisier and his committee at the Academy published the results of Linnaeus' suggestion in an *Essay on Chemical Nomenclature*.[12]

All modern day chemical nomenclature, in some way or another, can trace their origins to these early naming suggestions in which chemical species and biological species were viewed as being under one diverse classification umbrella. In human chemistry, this line of argument will be followed.

Prior to this naming convention revolution, it was realized that chemical species could be utilized to produce work; so as to possibly replace the various horse-drawn sources of power. Specifically, in 1679 French physicist Denis Papin, an associate Robert Boyle, used a pressure-temperature correlation that Boyle had formulated to build a bone digester, which is a closed vessel with a tightly fitting lid that confines steam until a high pressure is generated.[13] Later designs implemented a steam release valve to keep the high-pressure machine from exploding. By watching the valve rhythmically move up and down, Papin conceived of the idea of a piston and cylinder engine; he did not however follow through with his design.[14] Nevertheless, in 1697, using Papin's piston-engine designs, English engineer Thomas Savery built the world's first steam engine.

In each mechanical design, hydrocarbon molecules (e.g. wood or coal) and water molecules (e.g. steam) are configured in such a manner to produce work in a cycle of operations. The science that studies the dynamics and energetics of systems of chemical species that produce work is chemical thermodynamics. The primary objective of *chemical thermodynamics* is the establishment of a criterion for the determination of the feasibility or spontaneity of a given transformation.[15] In human life, i.e. in dynamic systems of reacting human species, the fundamental working transformation of interest is the interpersonal romantic relationship.

The basis of chemical thermodynamics originated from a century-long study of a heat engine cycle called the 'Carnot cycle', defined in 1824 by the French physicist Sadi Carnot. As such, to understand the energetics of life we must first understand the energetics of the Carnot cycle. To properly study the Carnot cycle from the correct perspective, we must first redefine the human organism or human molecule in chemical terms. In this manner, in addition to utilizing the concept of the human

molecule, we will also define the human organism to be a *chemical species*, which can be defined as follows:[16]

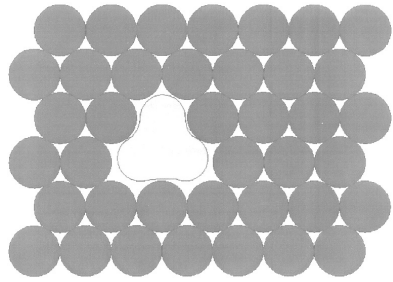
> **Chemical species** – an ensemble of chemically or categorically identical molecular entities that can explore the same set of molecular energy levels on a characteristic or delineated time scale; applying equally to a set of chemically or categorically identical atomic or molecular structural units in a solid, liquid, or gaseous array; embracing both cases where the basic structural units may not be capable of isolated existence, as well as those cases where they are.

This basic definition, subsequently, sets forth a basis on which to chemically study the human organism, their inherent interactions, and resultant transformations. In short, chemical species are categorized molecular entities. A molecular entity is a generalized term for singular entities, irrespective of their nature, while chemical species stands for sets or ensembles of molecular entities:

> **Molecular entities** – any constitutionally or isotopically distinct atom, ion, ion pair, radical, radical ion, molecule, supermolecule, mega-molecule, complex, conformer, etc., identifiable as a separately distinguishable entity.

The human being is a molecular entity that belongs to a class of chemical species called *Homo sapiens*. In this manner, any motile molecular entity, such as a carbon dioxide molecule CO_2 in the atmosphere, a water molecule H_2O in a pond, an anthropoid in an ecosystem, a human molecule in a spring break dance club, or an immobilized molecular structure, e.g. a molecular unit in a crystalline matrix, with a definite molecular formula, will each herein be defined as molecular entities categorizes as types of chemical species.

To clarify what is meant by the term 'isolated existence', we will refer to the related concept of matrix isolation. In general chemistry, *matrix isolation* is an experimental technique in which unstable guest species, such as free radicals, can be trapped in an unreactive matrix substrate, such as solid argon, and studied by spectroscopy.[17] The *guest* is said to be 'isolated' within the *host* matrix, as shown below:



Guest species (light gray) isolated in host matrix (dark gray)

The term matrix-isolation was originally used to describe the placement of chemical species in any unreactive material, often polymers or resins, but more recently has referred specifically to gases in low temperature solids.

By direct extrapolation, being that the human organism is a molecular entity, i.e. a structure comprised of atoms, we will apply this terminology to human life, in which one human molecular structure is born into the matrix of society, i.e. host matrix. This logic will also be applied to biological entities. Hence, any motile dynamic molecular structure from hydrogen to carbon-dioxide to ribonucleic-acid to bacteria to aquatic-worm to fish to reptile to treeshrew to human will herein be classified as types of chemical species, each embedded within a host matrix, which may or may not be reactive. Chemical species, generally, consist of a set of organisms that share a mate recognition system. Mate *recognition systems* are defined in terms of chemical compatiblites.[18]

To note, the terms chemical or molecular species, human species, biological species, biomolecules, molecules, etc., will be used synonymously herein. Each of these entities has a definite molecular structure; each can thus be classified as one or more types of chemical species; certain terminologies, however, seem fit to certain discussions. Molecular species and molecular subspecies, according to American chemist Ernest Grunwald, from his 1997 *Thermodynamics of Molecular Species*, for example, are at the very core of mechanistic chemistry, i.e. the study of reactions viewed in terms of the steps or stages through which molecular reconfigurations proceed. Grunwald's classification lists only those molecular species or subspecies that are chemically or stoichiometrically significant; but also leaves room for those molecular species that are not sharply discrete. Molecular species, subsequently, are the macroscopic ensembles of molecules that represent, in the real world, the molecules symbolized in chemical equations.

In chemistry, a *chemical equation* is a symbolic representation of a chemical reaction. It is a formula used to display different stages for chemical reactions, in which chemical species are changed into other species.[19] In human life, one of the more familiar chemical equations is the process in which a man *A* meets a women *B* and they bond or transform into a *working relationship C*:

$$A + B \rightarrow C \qquad [3.1]$$

In equation [3.1], the letters represent different types of chemical species. The single arrow (→) is used for irreversible reactions; double arrows (↔) are used for reversible reactions.[20] In human life, intimate, social, and community interactions correspond to chemical reactions; moreover, all forms of human bonding evolved in structure from simple atomic or chemical bonds, being either attractive, repulsive, indifferent, or combinations of the these three effects.[21]

In terms of work energy, chemical reactions come in two varieties: those which are *endergonic,* i.e. absorb energy in the form of work from the surroundings, and those which are *exergonic*, i.e. release energy in the form of work into the surroundings. The consummate example used to highlight this energetic distinction, is when a person gets to the point in an intimate relationship when he or she begins to openly declare that they are going to try to 'work' on their relationship.[22] This characterizes energy absorption. Typically, coherent relationships are exergonic; i.e. the bonded couple is content and as a unit and together they release energy in the form of productive evolutionary work out of their system and into the community.

Thus, some human interactions result to absorb energy in the form of work and others result to release energy in the form of work. To compound these distinctions, however, in chemistry, particularly in biochemistry, reactions tend to be 'coupled' such that one large exergonic reaction will tend to drive many small endergonic reactions. In human life, at an approximation, for every one giver there are at least two or more takers. On these views, we set forth the following quintessential definition:

> **Human chemical reaction** – a quantum mechanical process delineated within a thermodynamic system wherein old bonds are broken and or new bonds are formed according to which energy is either released into or absorbed from the thermodynamic surrounds.[23]

The five basic reactions are shown below:

Reaction	Name
$A \rightarrow B$	isomerization reaction
$A + B \rightarrow AB$	combination reaction
$AB \rightarrow A + B$	decomposition reaction
$AB + C \rightarrow AC + B$	single displacement reaction
$AB + CD \rightarrow AD + BC$	double displacement reaction

For most purposes in human chemistry, unless stated otherwise and in addition to the previously species *Mx, Fy, Bc,* etc., assignments, letters and symbols will be used to correspond to different human molecular configurations, such as two people, *A* and *B*, bonded together in a relationship, which can be written as *AB* or *C* dependint on the context of the discussion.

A human molecular isomerism reaction is a change in molecular structure (or molecular architecture), but without change in molecular formula. In other words, the same atoms remain in the molecular unit, but their three-dimensional structural

ordering, arrangement, or bonding configuration changes. These types of reactions are difficult to elaborate on per the exact definition of the term in human molecular reactions. Two people, for instance, may shift the bonding arrangements in their friendship or dynamic union, without significant atomic change to their personal molecular structures. In atomic detail, however, one will invariably find changes in neuroanatomical atomic structure correlative to these reactions. Combination reaction examples include the formation of a friendship as well as the process of engaging in a new occupation. A decomposition reaction would include a relationship breakup. An example of a single displacement reaction would be a tri-friendship structural rearrangement, in which a new friend joins the group and while doing so displaces someone. Goethe's famed novella *Elective Affinities*, as we will see, is situated over a double displacement reaction.

Curiously, then, in [3.1] we are presented with the contradictory viewpoint that *C* is both a single unit yet two distinct individuals? American psychologist Erich Fromm famously pointed this out in his popular 1956 book *The Art of Loving*:

> "In love the paradox occurs that two become one and yet remain two."

This paradox is resolved, however, by noting that species *C* is a single bonded unit comprised of distinct yet united molecular entities, i.e. two chemical species bonded or spatially attached in the form of a working dynamic evolving relationship.[24] The main characteristics of chemical species, human or otherwise, are distinguishability, possession of a definite molecular formula, configurational distinctive geometries, distinctive sets of molecular modes of motion, and spectral properties.[25]

To reiterate, any motile earth-bound structure, inorganic, organic, biological, or otherwise has a molecular formula. By this logic, those molecular structures that are motile and distinguishable can be classified as types of chemical species. Presently, we are able to calculate exact molecular formulas for chemical species comprised of eight elements or less, inert or animate; approximations are used otherwise.[26]

In connection with the description of a chemical equation, such as [3.1], which temporally characterizes, e.g. before and after, the process of a chemical reaction, we set forth the following basic definition of what constitutes 'life':

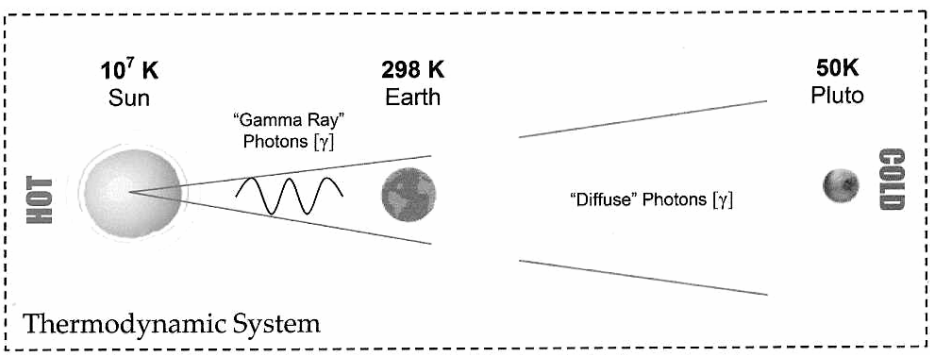
Life – a chemical or subatomic species in a state of evolution reactivity.[27]

This distinction is set forth for several reasons. First, current scientific theory has contrived of an imaginary day in history at about the 3.85 billion years ago mark in which biological life supposedly sprang forth from chemical life.[28] This is a misnomer. Biological life and chemical life are both one and the same.[29] Both

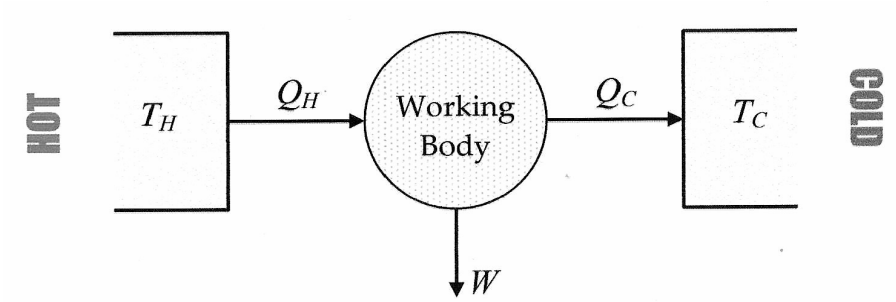
anthropomorphic terminological conceptions, in structural basis, are collections of thermally-active, boson-driven, molecular entities, differing only in atomic size, energy confinements, movement dynamics, and elemental composition, etc.

Second, life is based on point-of-view. Biological life is discernable from an anthropomorphic perspective, as this is the viewpoint at human time-energy levels. At higher energy levels, such as in the range of 10^{14} teraelectronvolts, for instance, the definition of sub-atomic 'life' comes into play. Third, this definition is meant to take into account subtleties or situations in which a chemical species, such as a living person, may technically be alive, but not necessarily alive *in life*, in the sense that one may be, for instance, in a burnt-out or non-evolving reaction, be it a job, a relationship, or otherwise, and not be alive in a real sense; as well as the converse situation in which one may feel 'so full of life'. In other words, having a pulse does not qualify life.

Typically, chemical species only react with other like chemical species from within the same energy level. In human life, examples are selective associations, assortive matings within class structures, social groupings, corporate levels, blue collars, white collars, laborers, friendship cliques, or divided town locations, etc. Each energy level is part of a hierarchy of adjoined levels.[30] Hierarchies are separated via what are called *system boundaries*, e.g. state lines, town borders, social boundaries, etc. Within each reactive system, rhizome-like structures tend to assemble in the form of nodes, hubs, links, and connectors, configured via power laws.[31] The total set of energy levels combine to form what is called the *earth system*, which is partitioned off by what is called the *Kármán line,* the boundary between atmosphere and space sixty-two miles above the earth's surface where weightlessness begins. The earth system, itself, is found within a larger thermodynamic system called the *solar system*, as shown below:



Within this thermal system, *heat moves from hot to cold, the work of evolution is driven by force, and there is a tendency towards dissipation.* This statement is what is known as the ***second law of thermodynamics***.[32] Thermodynamics, itself, is the study of engines and how *heat*, or energy in transit, relates to movement. The schematic model for any generalized heat engine is shown below:



Here, T_H and T_C are the temperatures of the hot and cold regions, respectively; Q_H and Q_C signify the heat flowing from and to the hot and cold regions, respectively; and W is the work produced by the process. The *working body*, a term introduced by German physicist Rudolf Clausius in 1850, consists of a system of interacting atoms and molecules that can be driven to produce work whenever heat is passed through its constituency. The original 'working body' was a system of water molecules, in the vapor phase, constructively used to push a piston up and down.[33]

The working body, when contained by a boundary, which may be selectively permeable and adjustable, technically is called a *thermodynamic system*. Every thermodynamic system exists in a particular *state*. A thermodynamic *cycle* occurs when a system is taken through a series of different states, and finally returned to its initial state. In the process of going through a cycle, the system may perform work on its surroundings, thereby acting as a heat engine. A *heat engine* operates by transferring energy from a warm region to a cool region of space and, in the process, converts some of that energy to mechanical work. This concise statement is human life in short. Namely, systems of human molecules, partitioned by boundaries, that do work in cycles (work cycles), constitute heat engines.

The first recorded heat engine, the *aeolipile*, was invented by the Greek engineer and geometer Hero of Alexandria in the 1st century AD, but used only as a toy.[34] To operate this amusing device, heat Q_H from the combustion energy of the fire would be transferred through the working body of the steam to the cooler atmosphere Q_L and thus used to produce the work W of rotation, i.e. to rotate the top bulb:

Aeolipile 100 AD

Intermediate in development between the invention of the aeolipile and the modern steam engine was the philosophical debate over the possible existence, or rather non-existence, of vacuums in nature.

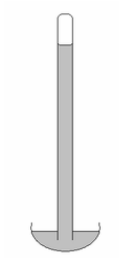
Vacuums in nature

A *vacuum* is a region or volume of space devoid of matter. In modern terms, a *perfect vacuum*, i.e. with a gaseous pressure of absolute zero, however, is never observed in practice. This is because quantum theory predicts that no volume of space can be perfectly empty. Much of outer space, for instance, with only a few hydrogen atoms per cubic centimeter, at ten femtopascal units of pressure, has the density and pressure of an *almost* perfect vacuum. It has effectively no friction, which allows stars, planets, moons, and asteroids to move freely along ideal gravitational trajectories. In contrast to this modern view, prior to the famed quantum revolution, with the hypothesis of the existence of massless light quanta, i.e. photons, by Albert Einstein in 1905, however, the issue of the vacuum was of some concern.

In short, in c. 485 BC Greek philosopher Parmenides, in his only known work, a poem conventionally titled 'On Nature', used verbal reasoning to postulate that a *void*, essentially what is now known as a vacuum, in nature could not occur. In c. 460 BC, Greek philosopher Leucippus, in opposition to Parmenides' denial of the void, proposed the *atomic theory*, which supposed that everything in the universe is either atoms or voids; a theory that according to Greek physicist and philosopher Aristotle was stimulated into conception so to purposely contradict Parmenides' argument.

The Greek philosopher Plato, student of Socrates and mentor to Aristotle, found the idea of a vacuum inconceivable. In c. 350 BC, in alignment with his mentor's ideas, Aristotle proclaimed, in opposition to Leucippus, the famous dictum *horror vacui* or 'nature abhors a vacuum'. Aristotle reasoned that in a complete vacuum, infinite speed would be possible because motion would encounter no resistance. Since he did not accept the possibility of infinite speed, he decided that a vacuum was equally impossible.

In 1643, Italian physicist Galileo Galilei, while generally accepting the *horror vacui* of Aristotle, believed that nature's vacuum-abhorrence is limited. Pumps operating in mines had already proven that nature would only fill a vacuum with water up to a height of thirty feet. Knowing this curious fact, Galileo encourages his former pupil, Italian physicist Evangelista Torricelli to investigate these supposed limitations. Torricelli did not believe that vacuum abhorrence was responsible for raising the water. Rather, he reasoned, it was the result of the pressure exerted on the liquid by the surrounding air. To prove this theory, he filled a glass tube, sealed at one end, filled with mercury and upended it into a dish also containing mercury:



Evangelista Torricelli's 1643 mercury column experiment

Torricelli found that only a portion of the tube emptied, as shown above; thirty inches of the liquid remained. As the mercury emptied, a vacuum was created at the top of the tube. This barometer-type vacuum effectively disproved Aristotle's theory and affirmed the existence of vacuums in nature.

Magdeburg hemispheres

In 1650, German inventor Otto von Guericke, stimulated by the work Galileo and Torricelli, to further disprove Aristotle's supposition that nature abhors a vacuum, constructed the world's first-ever vacuum pump and used it to unite the famous Magdeburg Hemispheres, a cylindrical copper vacuum:

Magdeburg hemispheres (1654)

A *vacuum pump* is a pump that removes gas molecules from any sealed volume to which it is attached, thus leaving behind a partial vacuum. The Magdeburg hemispheres were a pair of large copper hemispheres precisely cast so that their rims fit tightly together. When the rims were sealed with grease and the air molecules

were pumped out, the resulting sphere contained the world's first artificial vacuum. To get the air out of the sphere, von Guericke used his newly invented vacuum pump, which consisted of a piston and cylinder with one-way flap valves. To power the machine, several people would turn a crank arm connected to the vacuum pump. The Magdeburg hemispheres, which were about thirty centimeters in diameter, functioned to introduce Guericke's new vacuum pump to the world. When the air was sucked out from inside, they were held firmly together by the air pressure of the surrounding atmosphere.

Guericke's best-known performance, shown above, was carried out on May 08, 1654 before the Emperor Ferdinand III, and attracted crowds from all over Saxony. Before the emperor and a large crowd, Guericke greased the rims of the two hemispheres and carefully fitted them together. The local blacksmith then began vigorously pumping the air from inside the sealed copper globe. After a while, he was joined by his assistants, as the cranking of the pump gradually became more and more laborious. The crowd then watched as a team of eight horses harnessed together was led into the square and attached to one hemisphere of the copper globe. Another team of eight horses was then attached to the other hemisphere.

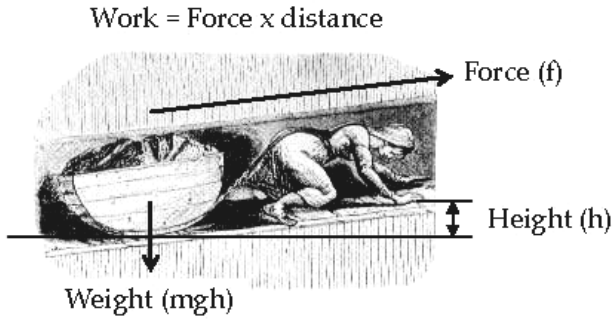
At the signal from Guericke, the two teams of horses strained forward in opposite directions, attempting to pull the two hemispheres apart, but no matter how hard they pulled, the horses could not separate the spheres. Guericke told the crowd that all that was holding the two hemispheres together was the pressure of the air surrounding them. The vacuum inside the sealed globe meant there was no opposing pressure to balance this great outer force. Later, von Guericke showed that in a vacuum sound cannot travel, candles could not burn, and animals could not live.

Guericke's experiment soon became so famous that he was demonstrating it all over Germany. Tales of his feat with the hemispheres soon spread all over Europe. Soon news of this phenomenon reached the likes of Robert Boyle, the first founder of modern chemistry. Based on Guericke's pump description, in 1954, Boyle and his assistant Robert Hooke made an air pump (the opposite of a vacuum pump) with an improved design, reduced size, increased performance, while making it easier to use. Utilizing this air pump Boyle devised experiments to explore the properties of air. He examined the behavior of sound, heat, light, electricity, magnetism, chemical reactions, e.g. a flame, and living systems, e.g. small animals or plants, in a vacuum.

Boyle also considered the behavior of air under extension or compression and from these experiments he formulated what is called *Boyle's law*, which states that the volume of a body of an ideal gas is inversely proportional to its pressure. Based on these studies, in 1679, Boyle's associate Denis Papin built a bone digester (pressure cooker) and from this design, he conceived of the piston and cylinder engine. This early work, stimulated English engineer Thomas Savery to build the world's first steam engine called the miner's friend.

Miner's friend

In 1697, the first functional heat engine, i.e. that which could perform useful work on a cyclical basis, called the 'Miner's friend', was built by the English engineer Thomas Savery. Savery's engine, essentially, was a vacuum pump that operated through the heating and cooling of steam in a cylinder. The heat engine was used to lift water and ore out of flooded iron mines throughout Europe. Savery's steam engine, and newer engine models to follow, would eventually replace working teams of horses, ponies, and people who had previously been used to do the work. Because mine tunnels were so narrow, for instance, children during these years were often given the job of hauling coal from underground:



A young "drawer" pulling a coal tub up a mineshaft (c. 1750).

In above diagram, we notice that the human molecule carrying coal, i.e. chunks of hydrocarbon molecules, up an incline is no different then Bartels' nano-walker or nano-worker carrying CO_2 molecules across a surface. Each (substrate-attached) situation, complexity aside, is no different than the other: both are molecules doing work, through the external influence of an energy-drive (force). There is no inherent difference between a nano-molecule and the human-molecule; a fact that takes a bit of getting used to.

Newcomen pump

In 1710, English blacksmith Thomas Newcomen improved upon the Savery engine by adding a spray jet, used to cool the cylinder, and by affixing a rocker-arm to the piston. Newcomen's engine was a kind of thermic siphon, in which steam was admitted to an empty container, forcing the piston up, and then condensed with cooling water, forcing the piston down. The piston, in turn, was connected to the arm of fulcrum. On the other side of the fulcrum beam was a chain attached to a pump at the base of the mine. During each power stroke, the vacuum thus created was used to suck water from the sump at the bottom of the mine. Newcomen's

engine, however, was not very effective and could not work beyond a limited depth of around thirty feet.

Watt steam engine

In 1763, Scottish instrument maker James Watt was given the job of repairing an early model of the Newcomen engine for the University of Glasgow. During his analysis of this engine, he noted how inefficient it was. Namely, during each engine stroke the hot iron cylinder had to be cooled down (a waste of energy), to make the vacuum, and then re-heated, to be able to hold the steam. Thus, if one could devise a way to make the vacuum without having to cool down the cylinder during each stroke, fuel could be saved. Subsequently, in 1765, while wandering across Glasgow Green, he conceived the idea of a separate condensing chamber for the steam engine. This is known as Watt steam engine:

Watt steam engine - located in the lobby of the Superior Technical School of Industrial Engineers of the UPM (Madrid)

Instead of spraying cooling water into the hot cylinder, which cooled the walls, walls that would then have to be heated up again, Watt's idea was to cool the working body of vapor in a separate area: the *condenser*, a second cylinder connected to the main one. In this manner, the main cylinder would remain hot continuously, and fuel would be saved.

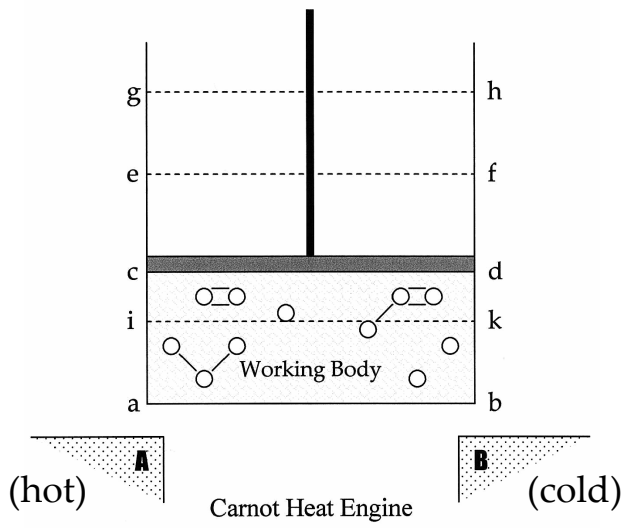
When the piston had reached the top of the cylinder, the inlet valve was closed and the connecting valve controlling the passage to the condenser was opened. External atmospheric pressure would then push the piston towards the condenser. Thus the condenser could be kept cold and under less than atmospheric pressure, while the cylinder remained hot. Subsequently, the working-body was the system of liquid-vapor (water molecules), the hot-body T_H was the furnace (a combustion

reaction of burning coal producing heat Q), and the cold-body T_C was a separate stream of cooling water (condenser), each of which the working body was put in alternating contact with in a series of steps in a cycle.

Hence, by the early 18th century, following these initial designs, heat engines came in many varieties, but they each had the commonality of a 'working body' of elastic fluid, typically a body of steam, contained with a piston-and-cylinder vessel, a furnace used as the *heat source*, and a stream of cooling water used as the *heat sink*. To perform work, the working body would be put into contact with the source and sink on alternate basis, creating a vacuum on the cooling phase, causing volume expansion and contraction, respectively. As such, the working body would be taken through a series of steps, of contraction and expansion, to complete one engine cycle.

Carnot's thermal cycle

The first-ever heat engine cycle described mathematically was the *Carnot cycle* as detailed by the great French physicist and founder of thermodynamics Sadi Carnot in his famous 1824 memoir 'On the Motive Power of Fire'. In his memoir, Carnot explains that the choice of working body is arbitrary; it could be, for example, vapor of alcohol, of mercury, of a permanent gas, or even a metallic bar alternately heated or cooled. For his cycle, Carnot used atmospheric air. In this manner, Carnot's example working body, or *working substance* as he called it, was a thermodynamic system comprised of approximately ten chemical species: nitrogen (N_2) 78%, oxygen (O_2) 21%, as well as argon (Ar), neon (Ne), helium (He), methane (CH_4), krypton (Kr), hydrogen (H_2), nitrous oxide (N_2O), and xenon (Xe), in smaller percentages.[35] A model of Carnot's original heat engine drawing, which shows a depiction of the working body of species, is shown below:



To cause this working body of chemical species to perform useful work, we are told 'to imagine two bodies *A* and *B*, kept each at a constant temperature, that of *A* being higher than that of *B*. These two bodies, to which we can give or from which we can remove heat without causing their temperatures to vary, exercise the functions of two unlimited reservoirs of heat.' We shall call the first the *furnace* and the second the *refrigerator*. Motive power or work, according to Carnot, can thus be obtained by carrying a certain quantity of heat *Q* from body *A*, through the working body of chemical species, to body *B*.

The engine cycle process is actuated by following a series of heat movement steps, as detailed by Carnot in seven stages (below). The reader should pay close attention to the steps and exact wording used in this heat cycle, for the 'Carnot cycle' is at the heart of the science of chemical thermodynamics, and thus of the dynamical study of the energetics of human life:

[1] Contact body *A* with the working body of chemical species enclosed in space *abcd* or with the wall of this space; a wall that we will suppose to transmit heat readily. The working body becomes by such contact of the same temperature as body *A*; *cd* is the actual position of the piston.

[2] The piston gradually rises and takes position *ef*. Body *A* is at all times in contact with the working species, which is thus kept at a constant temperature during the rarefaction. Body *A* furnishes the heat necessary to keep the temperature constant.

[3] Body *A* is removed, and the working body is no longer in contact with any body capable of furnishing it with heat. The piston meanwhile continues to move, and passes to position *gh*. The working body is rarefied without receiving heat, and its temperature falls. Let us imagine that it falls till it becomes equal to that of body B; at which point the piston stops, remaining at *gh*.

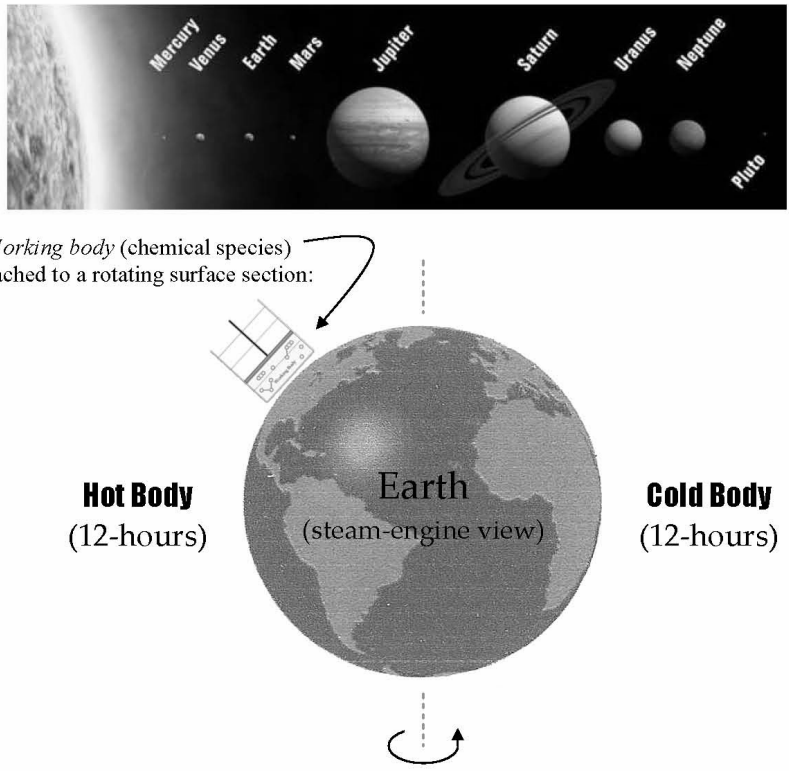
[4] The working body is placed in contact with body *B*; it is compressed by the return of the piston as it is moved from the position *gh* to the position *cd*. The working body remains, however, at a constant temperature because of its contact with body *B*, to which it yields heat.

[5] Body *B* is removed, and the compression of the working body is continued, which being then isolated, its temperature rises. The compression is continued till the air acquires the temperature of body *A*. The piston passes at this time from the position *cd* to the position *ik*.

[6] The working body is again placed in contact with body *A*. The piston returns from the position *ik* to the position *ef*; the temperature remains unchanged.

[7] The step described in 3 is renewed, then successively the steps 4, 5, 6, 3, 4, 5, 6, 3, 4, 5, and so on.

In this cycle, we can define two types of work being done by the working body. During the expansion phase when the piston is being pushed outward, in steps 1-3, we can define this as useful or positive work. Conversely, during the compression phase when the piston is being contracted inward, in steps 2-5, this constitutes negative or contraction work. The difference between the two constitutes the net work-output of the system. In addition, by letting body *A* be the warm day sky, body *B* be the cold night sky, then each day of the earth's rotation constitutes one Carnot cycle per region of working body attached to a section of the earth:



Moreover, by approximating the seven-day-week to consist of seven mini Carnot cycles, this heat-driven work sequence models the distinction between that of the *workweek* (positive work) and *weekend* (negative work). Technically, however, only the single day, can be considered as an exact Carnot cycle; nevertheless, this type of application is prominent in the field of *thermoeconomics*.[21] In the 2003 article 'Concepts of Thermodynamics in Economic Systems', German physicist Jurgen Mimkes, for instance, states that periodic work is always connected to two different economic levels: periodic production of industry and periodic production of households. Combined, according to Mimkes, 'these productions lead to the *Carnot process of monetary cycles*, which determine economic growth'.[21]

Clapeyron's indicator diagrams

The net amount of work produced by the working body, in one complete cycle, is the difference between the positive work and negative work. This *net work*, for this simple system, can be determined graphically by the integral of the product of the differential of the volume into the corresponding pressure over the cycle and is called pressure-volume work or *PV* work.[36] This pressure-volume work, in chemical thermodynamic terms, is represented by the following differential equation:

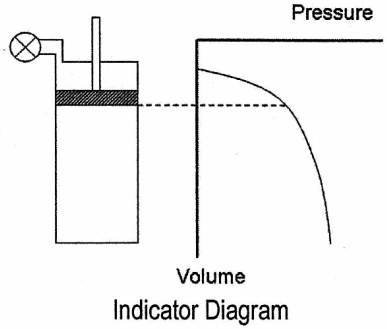
$$dW = PdV \qquad [3.2]$$

where dW is the work done by the system, P is the external pressure, and dV is the volume change. If we then integrate over the volume change, we obtain the work done by the system:

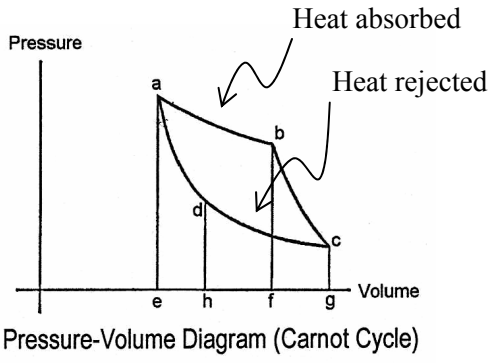
$$W = \int_{V_i}^{V_f} PdV \qquad [3.3]$$

In this direction, in the 1830s French mining engineer Émile Clapeyron began to use what are called 'indicator diagrams', i.e. engine cycle pressure-volume graphs, to put Carnot's theories on a rigorous mathematical footing. In the history of the development of the steam engine, the *indicator diagram* was a device developed by Watt and his employee John Southern to improve the efficiency of engines.[37]

The indicator diagram is simply a chart of the pressure of steam in a cylinder plotted against the steam's volume. In 1796, Southern developed the simple, but critical, technique to generate the diagram by fixing a board so as to move with the piston, thereby tracing the volume axis, while a pencil, attached to a pressure gauge, moved at right angles to the piston, tracing pressure. The basic indicator diagram is shown below on the left, with the corresponding pressure-volume diagram shown below to the right:



Indicator Diagram



Pressure-Volume Diagram (Carnot Cycle)

The gauge enabled Watt to calculate the work done by the steam while ensuring that its pressure had dropped to zero by the end of the stroke, thereby ensuring that all useful energy had been extracted. The total work could be calculated from the area between the volume axis and the traced line. Watt used indicator diagrams to make radical improvements to steam-engine performance while keeping it a trade secret. Though it was made public in a letter to the *Quarterly Journal of Science* in 1822, the procedure remained somewhat obscure; English mechanical engineer John Farey, Jr., for example, only learning of it when seeing it used, probably by Watt's men, when he visited Russia in 1826.[37]

Thus, by 1834, upon learning of this technique, Émile Clapeyron began to use an indicator diagram of pressure against volume to illustrate and elucidate the Carnot cycle, thus elevating it to a central position in the study of thermodynamics. He published his results, entitled 'Memoir on the Motive Power of Heat', that year, in the *Journal de L Ecole Polytechnique*. In 1843, Clapeyron's paper was translated into German and republished in *Annalen der Physick und Chemie*. It was largely though this translation that Carnot's results first reached the physicists.[38] Here we will use this indicator diagram, above (right), constructed by Clapeyron, as an example of how work is calculated in the Carnot cycle.

During the expansion phase, the system of chemical species *does work*, which is determined by the integral of the product of the differential of the volume into the corresponding pressure [3.3], and is there for represented geometrically by the quadrilaterals *eabf* and *fbcg*. During the compression phase, on the other hand, work is *expended*, which is represented similarly by the quadrilaterals *gcdh* and *hdae*. The excess of the former quantity of work over the latter is to be looked on as the whole work produced during the changes, and this is represented by the area of the quadrilateral *abcd*.[38]

This work-producing cycle can be looked upon as a representative energetic model for human life. This model, however, is in its most basic form, i.e. that originally conceived by Carnot. This framework will need to be expanded upon as each system becomes more complicated. Specifically, to measure the Carnot cycle pressure-volume work of partitioned-off, reactive systems, of human molecules, 'human indicator diagrams' need to be developed, in a manner rigorous to those developed by Watt and Southern for working systems of water molecules. This will be an area of future research and development.

At this point, although we are hugely oversimplifying many technical details, we can think of the area represented by *abcd* as the net amount of productive work, in this case pressure-volume work, done by a system of reactive chemical species, driven by an external heat source; a heat source, which in Carnot's example, is a furnace or boiler (body A). Work in biological and human terms comes in many varieties, immensely more complicated to describe mathematically than simple pressure-volume work, but the same basic principles apply.[39] In other words, the

hot sun is the furnace or boiler (body A), the working system is any group of reactive chemical species in a partitioned off subsystem of the biosphere, and the condenser is the cool night sky (body B).

Clausius' entropy

In 1850, Rudolf Clausius, a newly minted physics professor at the University of Zurich, wrote a seminal paper based on his analysis of the Carnot cycle entitled 'On the Moving Force of Heat and the Laws Which May be Deduced Therefrom.' In this influential paper, Clausius set out to examine a contradictory supposition in which Carnot had partly based his theory on, namely that 'no permanent change occurs in the condition of the working body in one complete cycle.' This postulate contradicted recent experiments, such as those which showed that heat could be produced by mechanical friction, such as when wooden carriage axles catch on fire. In 1840s, for example, the English physicist James Joule showed that by rubbing cubes of ice together, in a room colder than the freezing point of water, frictional heat could be generated. To explain this phenomenon, it was argued that a change in the positional arrangements and kinetic energies of the molecules, in the working body of ice, functioned, in some way, to generate heat.

Carnot had modeled his conception of heat partly on the eighteenth century views of French chemist Antoine Lavoisier in which both light and heat, or caloric as it was called, were composed of indestructible finite particles that had mass. Clausius, on the contrary, adopted the new view that heat Q was a form of *vis viva* or kinetic energy.[40] On this viewpoint, Clausius put forward the postulate that during any transformation, a portion of heat would be irreversibly consumed, i.e. not available for use externally, in the working body due to atomic kinetic energy interactions, atomic body frictional dissipations, intermolecular collisions, and molecular configurational rearrangements, etc. Clausius argued that heat was a form of frictional kinetic energy rather than a hypothetical flow of indestructible caloric particles.

Clausius, subsequently, spent the next sixteen years developing a rigorous and more accurate mathematical model of the internal energetic details of the Carnot cycle. He came to the argument that whenever a small amount of heat energy dQ is incrementally passed through the system boundary, a certain amount of heat driven change would ensue in the working body, which can be divided into three types. From his first of nine memoirs on the subject, Clausius states that in the production of work, at the same time a certain amount of heat is consumed, as molecules of the working body interact with each other, another quantity is transferred from a hotter to a colder body, and both quantities of this heat stand in definite relation to the work that is done.

Building on this logic, from his 1854 memoir, Clausius developed the concepts of *interior work*, i.e. 'those which the atoms of the body exert upon each other', and *exterior work*, i.e. 'those which arise from foreign influences which the body may be exposed'.[41] He then discusses the three types of heat by which Q can be divided:

1. Heat employed in increasing the heat actually existing in the body.
2. Heat employed in producing the *interior* work.
3. Heat employed in producing the *exterior* work.

From these fundamental postulates, the concepts of *internal energy* U, *entropy* S, and *work* W developed, respectively; being associated with the energy content of the working body, the transformation content of the working body, and the occupational content of the working body, respectively.

To review, as a first approximation, we will apply this model to human life. In this case, body A would be the warmer day sky, put in contact with numerous subdivided working bodies, i.e. partitioned reactive subsystems, of the biosphere, approximately twelve hours per revolution of the earth, and body B would be the cooler night sky, put in contact with numerous subdivided working bodies, i.e. subsystems, of the biosphere, approximately twelve hours per revolution of the earth. A point to note, however, is that, according to fossil records, the spin rate of the earth is variable: when the earth was one billion years old it rotated once every ten hours; four billion years from now it will rotate once every fifty-two hours.[42] This variation needs to be accounted for in the study of molecular species evolution on longer time scales.

The working bodies, in each system, are any set of interactive chemical species, e.g. human species, biological species, or atomic species, partitioned off by semi-permeable adjustable boundaries into evolution windows in which measures of migrations of new reactive species into or out of the system become negligible.[43] In short, to accurately apply the basic model of the Carnot cycle to human life, we need to study reactive human systems over time frames in which no new reactants enter or leave the system. This would be considered a closed system.

In thermodynamics, a *closed system*, as contrasted with an 'isolated system', can exchange heat and mechanical work, but not matter, with its surroundings. For a simple system, with only one type of particle, i.e. atom or molecule, this amounts to a constant number of particles. For systems which are undergoing a chemical reaction, however, there may be all sorts of molecules being generated and destroyed by the reaction process. In this case, the fact that the system is closed is expressed by saying that the total number of each elemental atom is conserved, no matter what kind of molecule it may be a part of. Mathematically this equates to:

$$\sum_{j=1}^{m} a_{ij} N_j = b_k^0 \qquad [3.4]$$

where N_j is the number of j-type molecules, a_{ij} is the number of atoms of element i in molecule j and b_i^0 is the total number of atoms of element i in the system, which remains constant, since the system is closed. There will be one such equation for each different element in the system.[44]

In human chemistry, to alleviate the technicalities involved in keeping track of each element, we will consider only those atoms or molecules entering or leaving a system that cause a significant energy change in the internal energy U of the system. This assignment requires a bit of thought. In other words, a single oxygen molecule O_2 passing into a dance club, for instance, will not noticeable affect the energetics of the system; whereas, conversely, a single famous supermodel (human molecule), entering the system will. Said another way, the human molecule will not have a mate recognition system in common with the oxygen molecule and as such it will not be stimulated to react (interact) with the oxygen molecule, significantly. Subsequently, the energy changes between the oxygen molecule and the human molecule will be negligible, whereas the energy changes involved in the interactions between two human molecules will be significant. Thermodynamic system analysis, to note, is an advanced topic; we will only outline this application herein. To summarize, any system of interactive *human molecules*, partitioned off, that produce work on a cyclical basis, by definition, can be considered a working body.[46]

In human terms, the simplest example of a working body would be a household that yields net occupational work-output on a cyclical basis. Another example of a working body would be a corporation in between hiring seasons. The basic human work cycle, as mentioned, is the seven-day-week, consisting of a five-part expansion or *work phase* (workweek) and a two-part contraction or *non-work phase* (weekend). Likewise, although the day is the basic Carnot cycle, the month, a season, a year, a decade, etc., all might just as well be considered as cycles. In a more complicated manner, the current world population of human molecular entities consists of an approximate six billion people divided among one-hundred and ninety-four sovereign nations.[47] Each nation, separated by regulated boundaries, performs a specific amount of internal work, e.g. local work, and a specific amount of external work, e.g. international commerce and trade, on a cyclical basis.

Again, a chemical working body, i.e. system, is said to undergo a *cycle* of transformations when the system returns to its initial state.[48] With the start of every calendar week, typically, human systems return to their initial state, and thus complete one work cycle, although the cycle is not reversible. Hence, for every differential quantity of heat dQ that enters the biosphere, traversing from body A (the sun) to body B (the cold night sky), three types of heat-driven activity will actuate: firstly, heat will be employed in increasing the internal energy U of the working body (subsystem of the biosphere), second heat will be employed in doing internal work (inter-species work within the subsystem), and third heat will be employed in doing external work (work released from the subsystem to the environment).

The dynamics here, to repeat again, are hugely oversimplified; this description is meant only to be a simple base model. The details of this process increases in complexity as each system increases in complexity. The original steam engines, by contrast, were systems of a simple nature. In any basic steam engine, we have configurations in which energy, in the form of heat, is transferred from one molecular system, i.e. hydrocarbon molecules and oxygen molecules chemical reacting via combustion reactions in the furnace, into three adjoined or connected molecular systems: air molecules of the working body, steel molecules of the piston, and the water molecules of the condenser. Hence, energy from one system, i.e. the furnace, is functionally modifying three other systems. When human operational configurations are divided up into similar such systems, we not only have inter-human-molecular, i.e. inter-personal, heat or energy transfer between adjoined human systems, but also geothermal and solar-thermal energy inputs to take into account as well.

Nevertheless, the energetic basis for each step of an engine cycle that defines these processes is called the *conservation of energy*. It states, as formulated by Clausius in 1850, that the change in the *internal energy U* of the working-body will be equal to the *heat Q* added less the difference of the *work W* done by the working body:

$$dU = dQ - dW \qquad [3.5]$$

This expression is one binding limit to the process of evolution. It is a certainty that *the variation in energy of a system during any transformation is equal to the amount of energy that the system receives from its environment.* This statement together with [3.5] are called the ***first law of thermodynamics***.[49] The first law, in short, is an energy balance equation for a system that changes from one (stable) equilibrium state to another nearby which differs in energy by *dU* while interacting with its environment by means of a heat interaction which transfers an amount of heat *dQ* and a work interaction which transfers an amount of work *dW*.[50]

Thermal molecular systems

When we study dynamic systems in which both the flow of energy and matter into or out of the system become significant then [3.5] must be modified accordingly, to take account the energy change that the migration of particles or species bring to the system. In this statement, we must differentiate between *reactive matter*, i.e. that which takes part in a chemical reaction (e.g. two humans), *substrate matter*, i.e. that upon which the reaction occurs (e.g. land), and *catalytic matter*, i.e. that which facilitates a reaction (e.g. a television).[51] This is a complicated distinction, which must be analyzed in detail for each process.

The first to analyze this difficult and intricate thermodynamic matter-energy-system problem was Russian physical chemist Georgi Gladyshev. In 1977, Gladyshev argued that to functionally apply the laws of classical thermodynamics to evolving systems one must first divide all systems into individual components based on temporal delineations.[52] The general evolution of matter and biological evolution, according to Gladyshev, can be regarded as set of parallel evolution processes. Subsequently, if each evolving 'set' is studied separately, within time-delineated evolving chemical transformation windows appropriate to system constraints, such a system can then be predicted to evolve towards a free energy minimum.

The earth-system as we have defined is divided up into various working-bodies comprised of numerous atoms and molecules, built from arrangements of ninety-two naturally occurring elements, through which heat passes in a cyclically manner, i.e. daily, weekly, monthly, seasonally, yearly sun cycles, etc. Every chemical species, within each working-body, cycles approximately through a forty-hour *workweek*; although variations exist, for instance, in which less evolved species tend to work more hours per day, and more evolved species tend to work less, i.e. be more efficient. Early hunters and gatherers, for instance, had to spend 12-16 hours a day gathering just enough food to stay alive, leaving little time for socializing and entertainment. After the onset of agriculture, however, working time decreased dramatically. Some countries, such as France (in 2000), have recently adopted the maximum 35-hour (6-hours per day) work week by law. In the new 2007, top-100 Amazon book *The 4-Hour Workweek*, by Timothy Ferriss, one is given tips on how to escape the 9-to-5, to live anywhere, and to join the new rich. In the biosphere, to review, the working-body may consist of any semi-closed system of interacting species through which heat fluxes cyclically.

The condition *semi-closed* stipulates that we choose windows of evolution in which migrations of chemical species into or out of the territory of the working-body are negligible. In human terms, this could be, for example, a school system (through which *school-work* is done), over the course of one evolutionary school year, in which the composition of the student-body and teacher-body remain relatively constant.[53] Similarly, ecosystems (through which *ecological-work* is done) during an individual growing season may be selectively modeled as semi-closed. Ecosystems are often separated by geographical barriers such as rock formations, deserts, mountains, or oceans; or may be isolated otherwise, as islands, lakes, or rivers.[54]

In many cases, the chemical species, on their own accord, setup and define impermeable boundaries closed to the flow of certain species. In the Gombe, in northeastern Nigeria, for instance, wild chimps patrol territories of up to five to eight square miles. Regularly, small groups of males steal along the border of their range, sniffing the ground for the trace of strangers, and climbing trees to peer across neighboring territories. When an unfamiliar chimp, all except childless females, comes too close, they charge, attack, and occasionally severely injure the intruder.

In one instance, an older female was attacked so severely by four males that she died five days later of her wounds.[55]

In 1970, in this same area, a chimpanzee war began. A splinter group of seven males and three females with their young split off from their comrades in the north of the reserve and began a group of their own in the south. For a while individuals met at the *border*, which we will define as a semi-permeable energy boundary, to solve their differences by loud calling, hurling branches and mock charges at each other. In 1974, five males from the original Gombe community began to roam deep into the southern territory. Within three years, they attacked and murdered all of the adult males and one old female, thus extinguishing the splinter group and extending their territory southward.[56]

Chemically, we can analyze this process from several perspectives. First, from the perspective of the boundary delineations of the two chimpanzee groups, which can be thought of as collectives of socially bonded, mate-selective, chemical species, we view this territorial expansion as an example of energy expended in the form of biological pressure-volume boundary work. This is analogous to the heat engine dynamics in which the molecules in the cylinder of the piston push or compete for space with the molecules of the surrounding atmosphere, as the piston is expanded in such a manner to extend the territory of the working body.

Second, whenever a single chemical species is transported from a system to its surroundings, *chemical work*, given by $-\mu_i dn_i$, is performed.[39] Here, μ_i is the chemical potential for the i^{th} species and n_i is the number of species transported. This, to note, is a more advanced topic in chemical thermodynamics. In short, however, *chemical potential* accounts for changes in the internal energy U of the working system with the passage of new reactive species across the boundary. In chimpanzee social systems, this would be equivalent to, for example, the amount of work time-energy spent in planning and executing covert operations in the neighboring territory; or it can be thought of the energy-effect that the intruder has on the system internally. In human work groups, this potential is equivalent to the energy change associated with the dynamics of a group whenever a new group member enters the ensemble. These boundary reaction examples characterize what are called *open thermodynamic systems*, in which work, heat, and matter can cross the boundary into the surroundings. The 'surroundings', to note, are only of interest if they have some influence on the evolution of the system.

Lastly, we can think of this example of an entire evolution process as a multi-year chemical reaction symbolized by the following chemical equation:

$$A + B \rightarrow C + D \qquad [3.6]$$

Here, over the course of about a dozen years, social collective A reacted violently with social collective B to form a new social collective C and a terminated or

modified social collective *D*. To clarify, social system *A* incorporated, by force, the females and children of social system *B*, so to chemically transform into a newer evolved social system *C*. The three or four year period of intense violence, in this example, would be defined as the *transition state*, being quantified as a high-energy peak in the reaction in which bond tensions are at their highest level.

The initiation point of any chemical reaction, such as those described here, can always be traced to a specific moment in time. The First World War, for example, was said to have started Sunday morning at 11 A.M. on June 28, 1914 when Gavrilo Princip, a nineteen-year-old Bosnian Serb student and member of the terrorist organization Black Hand, shot the Austro-Hungarian Archduke Franz Ferdinand.[57] Within thirty days following this decisive event, according to social historian Mark Buchanan, from his book *Ubiquity: Why Catastrophes Happen*, this led to a 'chain reaction' involving international threats and promises which mobilized vast armies tying Austria, Russia, Germany, France, Britain, and Turkey into a deadly knot. When the First World War ended five years later, ten million people lay dead.

Scientifically, since all chemical, biological, and social structures, including those such as cities and countries, have evolved, over billions of years, from ancient collectives of interactive hydrogen and helium atoms, we should expect to find comparative atomic and molecular analogs for all types of energy boundary interactions, such as these war examples.[58] In the atmosphere, for instance, atomic systems such as exosphere, thermosphere, and mesosphere, etc., set up and maintain selectively permeable boundaries to each other. Similarly, the polar cell, temperate cell, and tropical cell set up and define selectively permeable boundaries wherein select species are found.

When human boundary dynamics are studied, examples are numerous. The Kung people of southern Africa, to cite one example, have distinct boundary permeabilities. The Kung are extremely touchy about boundaries and will patrol areas of over one hundred square miles. Traditionally, in olden times, the penalty for intruders was death.[59] In war times, the 'front line' is the most dangerous area of the battle. In some countries, such as the U.S., half the yearly budget goes to defense spending, a form of boundary protection and regulation.[60] Moreover, as an example, recently the state of Texas has implemented a 'virtual' border along a 1,240 mile section of the Texas-Mexico boundary, in which community members can view live cameras via the internet to report suspicious activity.

To summarize, by modeling the entire earth as one gigantic working-body, comprised of collections of adjoined interactive working bodies, the parallel between the generalized-engine and the solar-engine is exact. Both processes are governed by the same laws.[61] Just as a waterwheel cannot be turned if all the water is at the same level, neither can human species react evolutionarily without the one-way flow of energy from the sun. According to the entropy theorist Jeremy Campbell, 'it is the

imbalance of a hot sun burning in the cool surroundings of space that powers the great engine of nature and civilization on this planet.'[62]

The modern-day definition of *work*, i.e. weight lifted through a height, was originally defined by the famous Sadi Carnot. Not only was Carnot the first to enunciate the second law of thermodynamics, but in addition, his theories on heat seeded the development of the science of thermodynamics. In biochemical and human terms, work is defined as follows:

Work – any activity energetically equivalent to lifting a weight.[63]

This definition derives from the fact that originally steam engines were used to lift water out of flooded iron mines throughout Europe. The Newcomen steam engine of 1711, for example, was able to replace a team of 500 horses that had previously powered a wheel to pump water out of mines. Based on this use, in 1824 Carnot stated:

> "We use here motive power (work) to express the *useful effect* that a motor is capable of producing. This effect can always be likened to the elevation of a weight to a certain height. It has, as we know, as a measure, the product of the weight multiplied by the height to which it is raised."

In human chemical thermodynamic terms, subsequently, work can always be related qualitatively to the 'useful effect' a human working-system is capable of producing and measured quantitatively in terms of the energetic equivalent of this effect or activity to that of lifting a weight through a height.

Using the steam engine framework to elaborate on this definition, for a working-body of interacting molecules, e.g. water molecules in the vapor phase, to produce *useful work*, a specific sequence of heat transfer processes must actuate. Each step of the process is delineated by a final-state and an initial-state. The initial state correlates to a thermodynamic system found out of energetic equilibrium; the end state corresponds to a thermodynamic system found to be in energetic equilibrium. Thus, according to Carnot, 'the production of motive power in steam-engines is always accompanied by a circumstance on which we should fix our attention. This circumstance is the *re-establishment of equilibrium* in the caloric (heat); that is its passage from a body in which the temperature is more or less elevated, to another in which it is lower.'

The key phrase mentioned here is 're-establishment of equilibrium'. In the earth system, owing to the continuous influx of solar energy (heat, gamma-ray photons, or caloric as it was termed in the 18th century) working systems of reactive chemical

species are periodically set out of equilibrium (day light). These periodic disequilibrium states create driving tendencies in which the work of evolution is the product.[64]

In the history of science the 'caloric theory' was a postulate that heat consists of a fluid called *caloric* that flowed from hot to cold bodies. Caloric was thought of as a weightless gas that could pass in and out of pores in solids and liquids. The caloric theory was abandoned by the mid-19th century in favor of the modern theory of heat, wherein heat is now defined as *energy in transit*.[65] In his writings, Carnot used the words heat and caloric somewhat interchangeably.

Carnot, for example, described the operation of the heat engine as follows: 'the caloric (heat Q_H) developed in the furnace by the effect of combustion traverses the walls of the boiler, produces steam, and in some way incorporates itself with it. The latter carrying it away, takes it first into the cylinder, where it performs some function (e.g. to push a piston, i.e. to do work W) and from thence into the cylinder, where it is liquefied by contact with the cold water which it encounters there. Then, as a final result, the cold water of the condenser takes possession of the caloric (heat Q_C) developed by the combustion.'

The earth as a whole can similarly be modeled as a heat engine. In the words of the German thermoeconomist Bengt Mansson:[66]

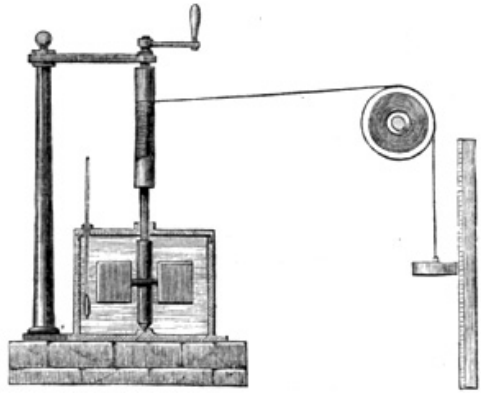
> "On a large scale, our planet may be described as a generalized heat engine, using energy to build and maintain structures."

On the premise, thermal energy, in the form of gamma-ray photons, i.e. heat Q_H, developed in the core of the sun by the effect of thermonuclear reactions traverses the *diathermal* (meaning permeable to heat) Kármán line boundary and incorporates itself with the outer-shell electron chemical structure of the biosphere. The latter, stimulated into action, performs some function such as atomic movement, e.g. to grow a sunflower, a form of doing work W, and from thence into a state of acquiescence in which it is reduced in intensity by contact with residual cooler night sky.[67] Then, as a final result, the ultra-cold temperature of space takes possession of the thermal energy, i.e. heat Q_C, developed by the solar furnace of thermonuclear reactions internal to the sun.

Joule's mechanical equivalent of heat

To complicate the matter further, not only can heat produce work, as Carnot showed, but in addition work can produce heat. The English physicist James Joule was one of the first to quantify this phenomenon in his famous 1843 paper 'The Mechanical Equivalent of Heat'.[68] In this paper, Joule showed that the work that can be obtained

by attaching a rope-and-pulley to a falling weight could be used to turn a paddle-wheel in a tub of water and thus to generate frictional heat in the water. This is diagramed below:



James Joule's 1843 paddle wheel experiment

In this experiment, owing to the agitational action of the paddle on the molecules of the working body (water molecules), frictional heat was generated; this heat could be quantified as a temperature increase by a thermometer.

To clarify, from the abstract to Joule's paper, 'a sort of paddle-wheel was placed in the can, to which motion could be communicated by means of weights thrown over two pulleys working on the contrary directions. He states that the force (work) spent in revolving the paddle-wheel produced a certain increment in the temperature of the water; and hence he drew the conclusion that when the temperature of a pound of water is increased by one degree of Fahrenheit's scale, an amount of *vis viva* (heat) is communicated to it equal to that acquired by a weight of eight-hundred and ninety pounds after falling from the altitude of one foot.' Based on this experiment, we now measure the unit of work W in *joules*, defined as the work done by a force of one newton acting over a distance of one meter.

In essence, what Joule showed was that whenever there occurs a change in the arrangement in the molecules of the working body, heat is generated. In other words, heat and work are 'equivalent'. In the years to follow, the *mechanical equivalent of heat*, as it was called, was a theory that heat Q and work W were equivalent via a proportionality constant A:

$$Q = A*W \qquad [3.7]$$

This formula, also called the 'theorem of the equivalence of heat and work', was a precursory form of the first law of thermodynamics. In 1854, by studying the works of both Carnot and Joule, the German physicist Rudolf Clausius enunciated this theorem as such:

> Mechanical work may be transformed into heat, and conversely heat into work, the magnitude of the one being always proportional to that of the other.

In addition, to take into account the dissipative reality that changes could occur in the condition of the working body whenever work is done by heat (as Carnot had assumed did not occur) Clausius introduced the thermal concept of *entropy* symbolized by *S,* which he initially defined as the 'equivalence-value' of all uncompensated transformations involved in a cyclical process of the working body. Essentially, entropy, according to Clausius, is a measure of the *irreversible energy* used for the work the molecules of the working-body do on each other during a cyclical transformation from one state to another as their arrangements and bonding relationships to each other change.[69]

Mathematically, to quantify the measure of this internal work energy, dissipated irreversibly, Clausius defined entropy to be equal to the ratio of the quantity of heat Q transferred into or out of the working body divided by the absolute temperature T at the boundary interface. Referring specifically to the forward expansion and reverse contraction phases of the Carnot cycle, Clausius declares: 'if two transformations which, without necessitating any other permanent change, can replace one another, be called equivalent, then the generations of the quantity of heat Q of the temperature T from work, has the *equivalence-value'*:

$$\frac{Q}{T} \qquad [3.8]$$

Having defined this ratio, let us take a moment to reflect. This quantity [3.8], called entropy, is the most profound and enigmatic ratio in all of science.

> Any method involving the notion of *entropy*, the very existence of which depends on the second law of thermodynamics, will doubtless seem to many far-fetched, and may repel beginners as obscure and difficult of comprehension.
>
> Willard Gibbs, 'Graphical Methods in the Thermodynamics of Fluids' (1873)

To elaborate on the mystique surrounding Clausius' entropy, in 1949 in a passing conversation between the Hungarian chemical engineer and polymath John von Neumann, the founder of game theory, and the American mathematician and electrical engineer Claude Shannon, the founder of information theory, von Neumann told Shannon that anyone who uses the word entropy in conversation will always be in a position of advantage. The reasoning behind this logic is that,

according to von Neumann, '*nobody knows what entropy really is*, so in a debate you will always have the advantage.'[70]

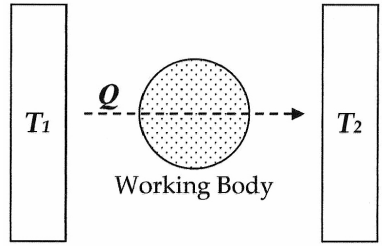
Moreover, over the past hundred and fifty years, as will be detailed in the next chapter, this ratio [3.8] of heat flow to temperature, i.e. entropy, has come to be associated with not only time, intelligence, evolution, and life, but also *beauty*. In other words, when one person finds another person to be perceptually beautiful, this alluring quality has something to do with ratio of heat to temperature.[71]

Next, Clausius states 'passage of the quantity of heat Q from the temperature T_1 to the temperature T_2, has the equivalence-value:

$$Q\left(\frac{1}{T_2}-\frac{1}{T_1}\right) \qquad [3.9]$$

Wherein T is a function of the temperature, independent of the nature of the process by which the transformation is effected.'

Expressions [3.8] and [3.9] are the first-ever mathematical formulations of entropy and entropy change, respectively; at this point, however, Clausius had not yet affixed the concept with the label entropy as we currently know it; this would come in the following several years.[72] In modern terminology, we think of this equivalence-value as *entropy*, symbolized by S. Thus, using the above description, we can calculate the entropy change ΔS for the passage of the quantity of heat Q from the temperature T_1, through the working body of chemical species, to the temperature T_2, as shown below:



Rudolf Clausius' 1850 thermodynamic system

If we make the assignment:

$$S=\frac{Q}{T} \qquad [3.10]$$

Then, the entropy change or 'equivalence-value' for this transformation is:

$$\Delta S = S_{final} - S_{initial} \qquad [3.11]$$

which equals:

$$\Delta S = \left(\frac{Q}{T_2} - \frac{Q}{T_1} \right) \qquad [3.12]$$

and by factoring out Q, we have the following form, as was derived by Clausius:

$$\Delta S = Q\left(\frac{1}{T_2} - \frac{1}{T_1} \right) \qquad [3.13]$$

To review, heat, in modern terms, is defined as *energy in transit*.[65] Temperature, similarly, is defined as a *measure of the tendency of a system to spontaneously give up energy*.[73] Hence, entropy, from one perspective, is an exotic ratio of energy quantifiers, i.e. the ratio of energy in transit through a system's boundary to the tendency of that system to spontaneously give up energy. A bit riddly, but then again, almost every branch of modern science has advanced greatly because of this riddled definition.

By defining this ratio [3.8], Clausius introduced a modified form of the second law of thermodynamics that would take into account energy loss due to internal heat dissipations associated with the effects of irreversibility within the working body. Thus, the atomic work energy associated with the irreversible changes in the organizations of the atoms and molecules of the working body during any transition was now on a mathematical footing. Presently, instead of heat Q moving from a hot region to a cooler region, as per the second law, we now have the quantity TS, from [3.8], moving from hot to cold and performing work in the process. TS can be interpreted as the amount of mechanical energy that has been converted into thermal energy by viscous dissipation and other system irreversibilities.[74] The application of this principle in human life processes, as we will see, is an intricate one.

In 1865, Clausius began to call [3.10] the 'transformation content' of the working body of chemical species, which he defined as the energy associated with amount of *internal work* done by the system of molecules, on each other, as they transformed through each step of the engine cycle. In his own words, 'we might call S the *transformation content* of the body, just as we termed the magnitude U its thermal and ergonal content. But as I hold it to be better terms for important magnitudes from the ancient languages, so that they may be adopted unchanged in all modern languages, I propose to call the magnitude S the entropy of the body, from the Greek word τροπη, *transformation*. I have intentionally formed the word *entropy* so as to be as similar as possible to the word *energy*; for the two magnitudes to be denoted by these words are so nearly allied their physical meanings, that a certain similarity in designation appears to be desirable.'

Clausius also argued that this entropic inter-molecular work-energy could be measured quantitatively in terms of changes in arrangements of the constituent molecules of the working-body, as these changes are measured between the final state and initial state of the evolution process.[72] In this manner, system heat loss due

to internal dissipation, molecular collisions, frictions, etc., as a result of the theorem equivalence of heat and work, can be quantified in terms of changes in molecular arrangements.

Entropy in biological and human evolution, subsequently, can theoretically be measured in terms of changes in bonding arrangements of the constituent biological or human molecular species of each working-body as measured between the final state and initial state of the evolution process. In human terms, the change in the arrangement of the life of the working body, which can be any system of at least two people interacting, gives a measure of the entropy change ΔS for that process. The structural, i.e. physical and mental, changes in an evolving relationship, for example, between the first honeymoon year and year ten, give a measure of entropy change. The modern-day understanding of the energetics of all chemical reactions are based on these founding postulates.

At this point, to summarize, we have covered the main functionalities of the first and second laws of thermodynamics. There are, however, five unique laws of thermodynamics in total. The other three laws are more advanced in detail and use; nevertheless, each, in their own unique way, applies to the process of human life in great clarity. The fourth law is the only one of the laws that is not yet a textbook law. In other words, there are many variations of the fourth law, mostly having to do with evolution, but they appear in scatter publications and books, but not in standard thermodynamic textbooks.[75]

The ***zeroth law of thermodynamics*** *states that two systems in thermal equilibrium with a third system are in thermal equilibrium with each other.*[76] This law is the basis for the concept of temperature T. In other words, any physical body, such as a column of mercury, or a panel of discerning humans, e.g. *hotornot.com*, etc., whose state can be varied, can be used to measure temperature. People as well as objects, for example, can be physically, neurologically, socially, intellectually, emotionally, or occupationally, etc., hot or cold.[77] A thermometer is an instrument used to gauge the thermal energy content of a system.

The zeroth law can also be stated as: 'the *transitivity* of the state of equilibrium, where two or more systems that interact and exchange energy and or matter will eventually reach the state of thermal equilibrium in which the temperatures of all systems are equal.'[78] In this manner, the zeroth law also explains why people work. In short, when a hot body, e.g. the burning sun, is put in contact with a colder body, e.g. the earth, for an extended period of time, e.g. a 12-hour day, the two adjoined bodies will strive to seek thermal equilibrium. That is, heat or energy in transit will flow from the hot body to the cold body and therein drive the atoms and molecules of the colder body to perform work, as the two systems *thermalize* with each other. In human systems, on average, hotter individuals, e.g. alpha males and females, will tend to work less hard than as compared to colder individuals, e.g. beta or gamma males or females.[79] Said another way, a 'physically' hot human molecule, e.g. an

attractive wife, in a bonded chemical relationship with a colder human molecule (physically speaking), e.g. a hard-working husband, can drive the latter to work, for years on end, and conversely, as the thermalize with each other via the zeroth law.

The ***third law of thermodynamics*** *states that the maximum work obtainable from a process can be calculated from the heat evolved at temperatures close to absolute zero*.[80] This law, in short, outlines the relationship between the chemical work released from systems of reacting species, the heat released or absorbed between the atoms and molecules of that system, and the entropy changes involved during those process, which ceases to change or becomes negligible at absolute zero. The third law plays a central role in the calculation of and theories on the measurement of interpersonal human molecular chemical affinities, such as Goethe's *Elective Affinities*.

The ***fourth law of thermodynamics*** is a matter of some debate. It may possibly be another century before one dominant fourth law precipitates. Examples are frequently found in physics, ecology, biology, and some come from fluid dynamics or chaos theory.[81] One commonly referred to fourth law are the set of Onsager reciprocal relations, from non-equilibrium thermodynamics, which together express the equality of certain relations between flows and forces in thermodynamical systems set *out of equilibrium*, but where a notion of *local equilibrium* exists.[82] Another prominent example of a fourth law, is that stated by ecologist Howard Odum: 'self-organizing systems tend towards the maximization of useful power.'[83] In sum, the five laws are summarized as:

Zeroth law of thermodynamics:

$$A \sim B \wedge B \sim C \Rightarrow A \sim C \qquad [3.14]$$

First law of thermodynamics:

$$dU = \delta Q - \delta W \qquad [3.15]$$

Second law of thermodynamics:

$$\int \frac{\delta Q}{T} \geq 0 \qquad [3.16]$$

Third law of thermodynamics:

$$T \to 0, S \to C \qquad [3.17]$$

Fourth law of thermodynamics (Onsager reciprocal relations):

$$J_u = L_{uu}\nabla\left(\frac{1}{T}\right) - L_{ur}\nabla\left(\frac{m}{T}\right) \quad [3.18]$$

$$J_r = L_{ru}\nabla\left(\frac{1}{T}\right) - L_{rr}\nabla\left(\frac{m}{T}\right) \quad [3.19]$$

In the following chapters, aside from the fourth law, we will show how the laws of thermodynamics apply in human chemistry. Of importance, in the following chapter the zeroth, first, second, and third laws of thermodynamics will be joined to yield a single 'combined' law that energetically governs the process of evolution as well as the activities of human life in general. In chapter ten, on Goethe's affinities, we will elaborate in an interesting manner on how the third law facilitates the calculation of affinities between reacting bodes.

4 – Combined Law of Thermodynamics:

"To heat are due the vast movements
which take place on the earth."

Sadi Carnot, French Physicist

In the 1620s, Flemish physicist Jan van Helmont noted that 'all life is chemistry'. Similarly, from the very famous 1944 booklet *What is Life?*, by Austrian physicist and Nobelist Erwin Schrödinger, we find 'life feeds on negative entropy'. In the last chapter, we learned that life is a quantum-mechanical, heat-driven, cyclical process whereby chemical species react, over substrate, to form new species and in which work, heat, and dissipation are derivatives. Life, from one perspective, then is a quantum, thermally driven, work producing, chemical reaction process that feeds on entropy. Yet, in simple terms, what does all this mean?

"Now, in the *second* law of thermodynamics . . . "

In order to understand these complex declarations and concepts we must first study the exquisite and rigorous branch of hard science called chemical thermodynamics. To elaborate on the mystique surrounding chemical thermodynamics, in college chemical engineering is known as the most intellectually difficult degree to obtain and likewise is the highest paying degree. Within chemical engineering, chemical thermodynamics is known as *the* 'weeder course', being that it will cause many engineers do drop out and change degrees with their first encounter with this subject. In other words, chemical thermodynamics the most difficult subject of them all.

In simple terms, by definition, *chemical thermodynamics* is the study of the interrelation of heat and work with chemical reactions or with a physical change of

state within the confines of the laws of thermodynamics.[1] Technically, every physical process or chemical reaction, including human and biological ones, can be examined thermodynamically.[2] The fruitfulness of such examinations, however, greatly depend upon the extent to which are known the fundamental properties of the change, i.e. the initial and final states of the reaction or process. This is a central viewpoint in both chemistry and human chemistry. The application of chemical thermodynamics into the realm of human reaction life, technically, is a more advanced subject of study called *human thermodynamics*, which is the study of energy and matter transformations in human reaction life processes.[3] Here we will only introduce this topic.

In the 2005 book *Basic Chemical Thermodynamics*, by physical chemist Brian Smith we find an excellent description on the wondrous yet cautious intrigue many have with their first encounter with chemical thermodynamics. In his preface, Smith states: 'the first time I heard about chemical thermodynamics was when a second-year undergraduate brought me the news early in my freshman year. He told me a spine-chilling story of endless lectures with almost three-hundred numbered equations, all of which, it appeared, had to be committed to memory and reproduced in exactly the same form in subsequent examinations. Not only did these equations contain all the normal algebraic symbols but in addition they were liberally sprinkled with stars, daggers, and circles so as to stretch even the most powerful of minds.'

This structure is that upon which human chemistry is built. Central to the science of chemical thermodynamics is an equation called the *combined law of thermodynamics*, which is a summation of the zeroth, first, second, and third laws of thermodynamics all combined into a single grand equation.[4] To review, the zeroth law of thermodynamics is the basis for the definition of temperature. The first law of thermodynamics sets limits to the amount of work that can be done by a chemical or physical process in proportion to the amount of heat absorbed or evolved.[5] From [3.5], it states that the change in the *internal energy U* of the working-body will be equal to the *heat Q* added less the difference of the *work W* done by the working body:

$$dU = dQ - dW \qquad [3.5]$$

The *second law of thermodynamics* deals with the natural direction of processes and the question of whether a given chemical reaction can occur by itself.[5] From [3.10], it states that the production of work in heat engines is due to the passage of heat from a warm source to a cold sink and that the *transformation-energy* associated with the modification of the working body during each step of the evolution cycle is defined, in differential form, by the following ratio:

$$dS = \frac{dQ}{T} \qquad [4.1]$$

In 1862, referring to [4.1], Clausius stated the second law in following way:

> “The algebraic sum of all the transformations occurring in a cyclical process can only be positive, or, as an extreme case, equal to nothing.”

To understand what is meant by this law we must define what is meant by the word ‘transformations’. In general, according to Clausius, when a body changes its state, work is performed externally and internally at the same time, the exterior work having reference to the forces which extraneous bodies exert upon the body under consideration, and the interior work to the forces exerted by the constituent molecules of the body in question upon each other. The interior work is for the most part so little known, and connected with another equally unknown quantity, i.e. with the internal energy U or with the increase of heat actually present in the body.

Moreover, if we avoid calculations of internal energy, we can conceive of a perfect cycle in which the organizational life of the system of chemical species is in exactly the same arrangement at the beginning of the cycle as it is at the end. That is, if we consider only ideal hypothetical cyclical processes, namely operations in which the modifications that the body undergoes are so arranged that the working body finally returns to its original condition unchanged, then we can state that the energy associated with the positive and negative transformations will cancel each other out. In such operations the interior work which is performed during the several modifications, partly in a positive sense and partly in a negative sense, neutralizes itself, so that nothing but exterior work remains, for which the theorem in question, namely that *heat cannot, by itself, pass from a colder into a warmer body*, can then be demonstrated with mathematical strictness.[6]

In addition, as Clausius states, ‘if the temperatures of the two bodies differ, heat passes, either from a warmer to a colder body, or from a colder to a warmer body, according to the direction in which the transference of heat takes place. Such a transfer of heat may also be designated, for the sake of uniformity, a *transformation*, inasmuch as it may be said that *heat of one temperature is transformed into heat of another temperature*.’ Moreover, ‘the two kinds of transformations that have been mentioned are related in such a way that one presupposes the other, and that they can mutually replace each other. We call transformations which can replace each other *equivalent*.’

Next, Clausius highlights the fact that expressions [3.8] and [3.9] further enable us to recognize the positive or negative sense of the transformations. In the first, Q is taken as positive when work is transformed into heat and as negative when heat is transformed into work. In the second, we may always take Q as positive, since the

opposite senses of the transformations are indicated by the possibility of the difference:

$$\frac{1}{T_2} - \frac{1}{T_1} \qquad [4.2]$$

being either positive or negative. It will thus be seen that the passage of heat from a higher to a lower temperature is to be looked upon as a positive transformation, and its passage from a lower to a higher temperature as a negative transformation.

If we represent the transformations that occur in a cyclical process by these expressions, [3.8] and [3.9], the relation existing between them can be stated in a simple and definite manner. If the cyclical process is reversible, the transformations which occur therein must be partly positive and partly negative, and the equivalence-values of the positive transformations must be together equal to those of the negative transformations, so that the algebraic sum of all the equivalence-values become equal to zero.

Conversely, if the cyclical process is not reversible, as life is, the equivalence values of the positive and negative transformations are not necessarily equal, but they can only differ in such a way that the positive transformations predominate. This means that there will be a quantitative amount of heat-energy associated with the internal work done in rearranging the molecules of the working body. The theorem respecting the equivalence-values of the transformations, as noted, may accordingly be stated thus: *the algebraic sum of all the transformations occurring in a cyclical process can only be positive, or, as an extreme case, equal to nothing.*[6]

The mathematical expression for this theorem, according to Clausius, is stated as follows. Let *dQ* be an element of the heat given up by the body to any reservoir of heat during its own changes, heat which it may absorb from a reservoir being here reckoned as negative, and *T* the absolute temperature of the body at the moment of giving up this heat, then the equation:

$$\int \frac{dQ}{T} = 0 \qquad [4.3]$$

must be true for every reversible cyclical process, and the relation:

$$\int \frac{dQ}{T} \geq 0 \qquad [4.4]$$

must hold good for every cyclical process which is in any way possible. In human chemistry, subsequently, [4.4] holds good for every cyclical process in human life.

In a more direct manner, Clausius postulates that ‘in all cases in which the heat *dQ* contained in the working body does mechanical work *W* by overcoming resistances, the magnitude of the resistances that it is capable of overcoming is proportional to the absolute temperature *T*.’ In human chemistry, these resistances,

Clausius speaks of, are the resistances encountered daily in the process of life in the pursuit of objectives and are accounted for quantitatively via infinitesimal changes in the measure of entropy. Entropy, from this perspective, then is a proportionality factor between the absolute temperature and the quantity of heat transferred into or out of a system during any transformation process in which either heat produces work or in which work produces heat. Using [4.1], this verbal statement equates to:

$$dQ = TdS \qquad [4.5]$$

Following this, Clausius states 'in order to understand the significance of this law, we are required to consider more closely the processes by which heat can perform mechanical work. These processes always admit of being reduced to the *alteration* in some way or another of the ***arrangement*** of the constituent parts of the working body.' This sentence is the origin of the order-disorder perspective of entropy.

Moreover, 'when a body changes its state, work is performed *externally* and *internally* at the same time, the exterior work having reference to the forces which extraneous bodies exert upon the body under consideration, and the interior work to the forces exerted by the constituent molecules of the body in question upon each other.' In human chemistry, the molecules are human beings and the forces exerted are the ways in which humans act on each other in both agreeable and disagreeable ways. In other words, in both cases, the measure of the alteration of the constituent parts of the working body is called entropy.

When applied to human molecular systems, by extrapolation, it is obvious that entropy, in a quantitative way, has a direct relation to the energetic measure of the forces exerted by the constituent human molecules of collective working systems, in question, upon each other, as these groups of reactive chemical species overcome irreversible resistances during each daily Carnot cycle. In this direction, following the publication of Clausius' memoirs, researchers have forever since been trying to correlate life, in some way, to measurements of entropy.[7]

In 1914, in his book *Human Chemistry*, as discussed, marine engineer William Fairburn reasoned that people could be classified not only by their weight, height, dimensions, or proportions, but also by their momentum or 'speed of thinking', their electricity or 'relative energy enthusiasm', but also by their 'personal entropy', which Fairburn loosely defines as 'temperature changes likened to coolness, passion, explosiveness, and frigidity.'[8] In 1944, Schrödinger declared, in sloppy fashion, that humans feed on entropy. In 1990, American sociology professor Kenneth Bailey published an entire book on *Social Entropy Theory.* Entropy, however, is only half the picture. To make sense of entropy, one must consider both the energy and entropy of any working system in the various states of which it is capable. The first to do this was Willard Gibbs.

Gibbs' general theory of chemical equilibrium

In 1870s, building on the foundation works of Carnot, Clapeyron, and Clausius, American mathematical physicist Willard Gibbs, undertook a methodical study of Clausius' versions of the first two laws of thermodynamics. In 1873, and over the next six years, Gibbs published a series of fundamental papers, comprising about 400-pages, focused on 'The Equilibrium of Heterogeneous Substances'.[9] The seed and terminology for these exceptional papers stem from French chemist Antoine Lavoisier's 1787 *Elements of Chemistry*.

In the opening chapters of this founding chemistry book, Lavoisier elaborates on the applications of Boyle's vacuum (1654) and Papin's digester (1679) and outlines the rudiments of the basic laws of thermodynamics, stating that 'caloric tends to become in *equilibrio* in all bodies', that caloric 'passes' from hot to cold bodies, and that 'elective affinities' are responsible for or are the cause of chemical combinations and decompositions.[10] The theory that all chemical reactions and the work energy released therefrom are due to the actions of elective affinities or chemical attractions, i.e. intermolecular forces, as we will elaborate on in chapters ten and eleven, in the 19th and 20th century, slowly evolved, theoretically and mathematically, into the thermodynamic conception of the *Gibbs free energy G*, which is the chemical energy of a system 'freely' available to be converted into other forms of external work.[11]

Lavoisier argued that by using the high pressures and temperatures obtainable in Papin's digester, that it would be possible to transform 'stones, salts, and the greater parts of the fusible substances which compose the mass of the earth' into fluids and gases. In the opposite sense, he also reasoned that if 'the earth were suddenly transported to very cold regions' that the elements which comprise the 'seas, rivers, and springs, and probably the greater number of fluids we are acquainted with, would be converted into solid mountains and hard rocks, and first diaphanous and *homogenous*, like rock crystal, but which, in time, mixing with foreign and *heterogeneous* substances, would become opaque stones of various colors.'

In sum, Lavoisier postulates that, by adjusting the temperature and pressure accordingly, it would be possible to change air or 'aeriform fluids' to a 'liquid state of existence' and a liquid states to a solid states. Based on these suppositions, he outlined the corollary that 'solidity, liquidity, and aeriform elasticity, are only three different *states* of existence of the same matter, or three particular modifications which almost all substances are susceptible of assuming successively, and which solely depend upon the degree of temperature to which they are exposed; or, in other words, upon the quantity of caloric with which they are penetrated.'

This statement of phase transformation is essentially modern, with the exception that Lavoisier's quantity of *caloric*, flowing through bodies, is now the equivalent of quantities of *energy and entropy*, flowing through working bodies. Curiously, in a side note, Lavoisier states that 'these speculations carry me from my objective,

which I hasten to return.'[10] In short, Gibbs picked up where Lavoisier left off; with the exception that he used the concepts of energy and entropy flows rather than caloric flow. At one point in his writings, as mentioned, Gibbs noted the advanced nature involved in this approach, when he stated that any method involving the notion of entropy may repel beginners as obscure and difficult of comprehension.[12]

In his 1873 paper 'Graphical Methods on the Thermodynamics of Fluids', the first of three, Gibbs introduced the world to the preliminary mathematical outline of an energetic principle able to predict or estimate the tendencies of various natural processes to ensue when systems or bodies are brought into contact. In his second paper, 'A Method of Geometrical Representation of the Thermodynamic Properties of Substances by Means of Surfaces', Gibbs indicates a piqued curiosity over the potential implications of his findings:

> "These results are interesting, as they show us how we might *foresee* whether two given states of a substance of the same pressure and temperature, can or cannot exist in contact."

Cautiously, however, Gibbs mentions that we must leave of account the cases in which we regard the states of coexistence as chemically different from one another. This clarification, as well as the possibility of chemical reactions, and the additional effect of possible migrations of chemical species between systems would soon be accounted for in his exquisite 1876, 300-page paper, titled 'On the Equilibrium of Heterogeneous Substances.' Nevertheless, with tremendous enthusiasm, we find Gibbs speaking about the potential ability of the laws of thermodynamics to be able to predict the future of chemical reactive processes.

The next bold step is the direct application of these laws into the dynamic arena of human relationship life, which are essentially coupled sets of chemical reactions. Chemical thermodynamics, in theory, has the potential to be able to energetically determine or foresee whether two human chemical species, such as a man or woman desiring union, can or cannot exist in stable or harmonious contact. This objective, to note, is an advanced topic in human thermodynamics; we point it out here as an interesting aside and indicate that it is an area of future research.

Next, using carbonic acid H_2CO_3, in the liquid phase and gas phase as examples, Gibbs states 'if we had carried it from a state of liquidity to a state of gas of the same pressure and temperature, making the proper measurements in the process, we should be able to *foretell* what would occur if these two states of the substance should be brought together—whether evaporation would take place, or condensation, or whether they would remain unchanged in contact—although we had never seen the phenomenon of the coexistence of these two states, or of any of the two states of this

substance.' Gibbs here speaks about the ability of chemical thermodynamics to foretell the coexistence of bodies of chemical species.

During these years, by studying the interactions of homogeneous substances in contact such as bodies in composition being part solid, liquid, and vapor, and by using three-dimensional graphs showing the relations between the volume, entropy, and internal energy of bodies in contact, Gibbs was able to determine three states of equilibrium for such contacts: 'necessarily stable', 'neutral', and 'unstable'.[9] When these three stability states exist in human molecular life, during reactive and energetic contacts between people, they qualify different states of *life equilibriums*; states that can be quantified by free energy changes in the system.

Structured on this premise, Gibbs derived a fundamental combined equation able to account for the three states of equilibrium whenever systems of working chemical species are bought into contact. To do this, Gibbs first defined pressure-volume work, as was done initially by Clapeyron in 1834, as:

$$dW = PdV \qquad [3.2]$$

Then, by substituting [4.5] and [3.2] into [3.5], with some rearrangement, Gibbs arrived at the following tremendous expression:

$$\delta(U - TS + PV) = 0 \qquad [4.6]$$

The differential symbol δ here, according to Gibbs, is the 'variation produced by any variations in the state of the parts of the body.' In his own words, to summarize his new *equilibrium principle*, Gibbs states that this single equation [4.6] expresses 'the necessary and sufficient condition of thermodynamic equilibrium for a substance when surrounded by a medium of constant pressure and temperature.' In human chemical terms, this postulate equates to the effect that [4.6] determines the necessary and sufficient conditions for equilibrium in human life, i.e. the point or time at which the reactions, changes, and evolutions will cease, e.g. when an intimate relationship stops working or evolving.

The condition of *stable equilibrium*, according to Gibbs, is that 'the value of the expression in the parenthesis of [4.6] shall be a minimum.' In this manner, systems of human species are collections of working bodies surrounded by constant pressure and temperature. Subsequently, in theory, by defining the necessary and sufficient thermal boundary conditions, expression [4.6] applies absolutely to the prediction of *relationship stabilities* in human life.[13]

To review, U is the internal energy of the working body. The quantity PV is simply the pressure-volume work dW, which accounts for the energy exchanged between the working body, an adjustable moving boundary, such as a piston, and the surrounding atmosphere. The quantity TS, or entropy multiplied by the absolute

temperature, accounts for the use of internal working energy during a non-reversible transformation.[14] To clarify this point further, from recent 2001 textbook *Biological Thermodynamics,* by American biophysicist Donald Haynie, the second law for biological systems declares that:

> “Any system not at absolute zero has some minimum amount of energy that is a necessary property of that system at that temperature; this energy, which has a magnitude *TS*, is isothermally unavailable.”

To summarize, expression [4.6] calculates the condition of equilibrium in isothermal, isobaric chemical systems and is the precursory equation form of Gibbs' general theory of chemical equilibrium, which he would fully elaborate on three years later in 1876.

In short, in the years to follow Gibbs showed that it is possible to energetically-study reacting systems in which both heat and chemical species move into or out of the working-body so to produce useful work as the system evolves towards the equilibrium points during each step of a transformation. To elaborate, from the opening line of his famous 1876 paper: 'the comprehension of the laws which govern any *material system* is greatly facilitated by considering the energy and the entropy of the system in the various states of which it is capable.'[15]

This paramount sentence applies equally to the study of any socially reactive work producing human system. Namely, the comprehension of the laws which govern any *human reactive system* is greatly facilitated by considering the energy and the entropy of the system in the various states of which it is capable. This is the starting point for any study of human life. The quantitative measurement of energy and entropy in human mechanistic life, however, is the difficult part. This inherent difficultly is due to the fact that we do not yet have the equivalent of thermodynamic instruments, such as thermometers, barometers, and calorimeters, set to gauge energy and entropy measures of human reactions.

In discussing the path of the working body as it changes from one state to the next, Gibbs tells us: 'suppose the body to change its state, the points associated with the states through which the body passes will form a line, which we may call the *path* of the body. The conception of a path must include the idea of direction, to expression the order in which the body passes through a series of states. With every such change of state there is connected in general a certain amount of work done W and of heat received Q which we may call the *work* and *heat* of the *path*.' This statement, essentially, is the sum process of human life in one sentence. Said another way, the essence of life can be boiled down to the process in which people follow along a *life path*, doing work, overcoming resistances, being driven by solar thermal photonic heat Q along the way.

These beautiful energetic models, although we are skipping over a great deal of mathematical development, subsequently, provide a way in which to chemically and energetically understand the process of human life, in which systems of interacting i.e. reacting human chemical species, as societies, states, corporations, groups, relationships, etc., produce work-output as solar heat energy Q_H is cycled into the biosphere periodically, i.e. daylight hours and lunar-periods that combine to output the typical workday, workweek, quarters, seasonal-work, years, etc. These periodic solar energy influxes actuate to drive forward human work-cycles. Human work-cycles, in theoretical structure are identical to the typical engine-cycle, e.g. there being a *positive* work phase (workdays) and a *negative* work phase (evenings); which are technically defined, according to Clausius, as 'positive' and 'negative' transformations, respectively.

Grouping terms from expression [4.6], the *enthalpy*, symbolized by *H*, also called 'heat content', is defined as the sum of the internal energy of a thermodynamic system plus the energy associated with work done by the system on the atmosphere, i.e. the product of the pressure times the volume. Enthalpy reflects the number and kinds of chemical bonds in the reactants and products.[16] In equation form, enthalpy is defined as follows:[17]

$$H = U + PV \qquad [4.7]$$

The quantity *H*, equal to the internal energy plus the pressure volume energy, was first recognized by Gibbs as playing an important role for processes occurring at constant pressure, and was called by him 'heat content'. Some years later, in 1909, the Dutch physicist Kamerlingh-Onnes gave *H* the name enthalpy, from the Greek εν (*en*) 'in' and θαλπος (*thalpos*) 'to heat', which combined define the word *enthalpos*, to warm within. In human intimate terms, enthalpy correlates to the heat of passion within relationships. Using this definition [4.7] of enthalpy, [4.6] reduces to:

$$\delta(H - TS) = 0 \qquad [4.8]$$

Grouping terms from expression [4.8], the *Gibbs free energy*, symbolized by *G*, is defined as the energy that is freely available to do work, i.e. the difference between the total energy *H* and the energy that is not available *TS* to do work, and equates to:

$$G = H - TS \qquad [4.9]$$

In human intimate relationship terms, in [4.9] we see that the free energy *G*, i.e. the working energy of the evolving relationship, is balance between the enthalpy *H* of the reaction, i.e. the physical heat of passion, and the entropy *TS* of the reaction, i.e.

the energy of the ordering or disordering effect of the reaction. Using this definition, [4.8] reduces to:

$$\delta(G) = 0 \qquad [4.10]$$

Thus, according to [4.10] the condition of *stable equilibrium* occurs when the value of the expression in the parenthesis, namely the Gibbs free energy *G*, shall be a minimum. This is best visualized graphically, as we will show.

In evolving dynamic systems, stable equilibrium is a fundamental condition or thermodynamic state to which the molecules of a system strive. Thermodynamic equilibrium, according to ecological thermodynamicist Eric Schneider, is a major 'attractor' for all natural systems.[18] In a system consisting of a newly formed reacting married couple, for example, the initial state of their combined life will not be near to perfect thermodynamic equilibrium. As such, their relationship will evolve, as they spend their working potential along the way, in such a manner so as to seek a state of perfect life order. This is an attractor for the couple. In evolving biological systems, the Gibbs free energy measures the maximum amount of work that can be done by a process going from a non-equilibrium state to an equilibrium state at constant temperature and pressure.[19]

In human life, at an approximation, the change in the Gibbs free energy, during any full-life evolution reaction, measures the maximum occupational work output that can be obtained in going from an initial non-equilibrium state, e.g. the juvenile state (instability), through multiple Carnot solar work cycles, to a final equilibrium state, e.g. the retirement state (stability). In finite detail, however, each specific reaction must be examined fully and related energy 'coupling effects' must be accounted for in a complete free energy analysis.

To summarize, in biological systems, i.e. subsystems within the biosphere at constant temperature and pressure, human social systems included, work is measured via a quantity called the Gibbs free energy *G*, which is qualitatively defined as that portion of a system's energy allotment *freely available to do work*.[20] Conversely, the system's temperature multiplied by the measure of the system's entropy, i.e. *TS*, is defined as that portion of a system's energy allotment *not available to do work*.[20]

This distinction between the two types of system energy was point out originally by German physician and physicist Hermann von Helmholtz in 1882. Helmholtz argued that instead of focusing on heat alone one should distinguish between the portion of energy that appears only as heat and the portion of energy that could freely be converted into other kinds of work, such as mechanical or electrical work. This latter part Helmholtz called 'free energy'.[21]

Helmholtz's argument and his mathematical derivations, which were semi-original, but influenced by the theories of Gibbs and the work of Clausius. In the 1854, Clausius had stated, in a phrasing similar to that of French chemist Antoine

Lavoisier, with his theory of 'combined heat', that during a complete cycle there is a *Verwandlungsinhalt* or 'bound transformation content', which he denoted by the integral of [4.1] between T_1 and T_2, and which he later termed entropy (1865).[22] On this terminology, Helmholtz conceptually divided the portion of the total energy *U,* that is in a system and available for conversion to other forms, as 'free energy', *G* or *F*, and the residual 'bound energy', *TS*. The symbol *F*, to note, is the isothermal, isochoric, i.e. constant-temperature, constant-volume, free energy, which is called the *Helmholtz free energy*.[23] Entropy, or the quantity *TS*, as mentioned, is also defined in terms of the work the chemical species of the system do on each other, a type of work or energy that can be thought of as being 'bound' in the system; energy that cannot be used for external work purposes. Entropy, again, is also a measure of the order or disorder of a system, in relation to the evolving (cyclical) arrangement of atoms, molecules, and species of the working body.[24]

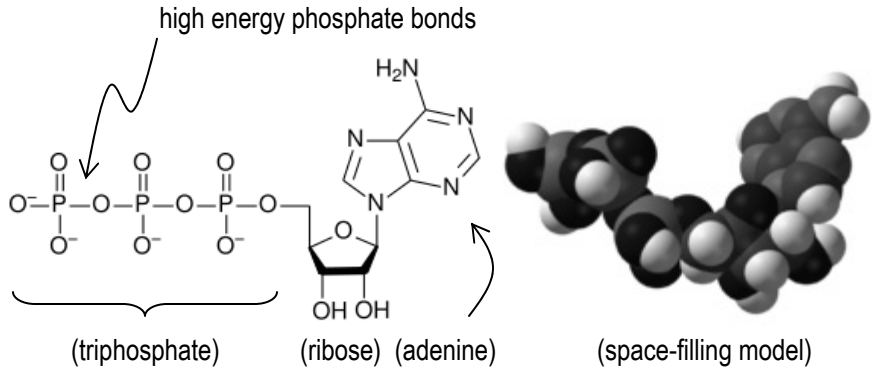
To highlight these terms, the pinnacle example would be the situation in which a married or dating couple reaches the point in the evolution process of their reaction in which they expend so much time and energy 'working' on their relationship, i.e. internal work, which equates to trying to keep their combined life in 'order' and not in chaos, that eventually the functional process of their working relationship ceases to operate and breaks apart. This type of situation, when not coupled to another stronger driving reaction, such as family peer pressure, friendship influence, or financial arrangements, etc., would be technically called a non-working *endergonic relationship*, meaning that energy in the form of work is going into the relationship rather than out of it, which is an unstable situation. Conversely, an *exergonic relationship* would be one in which the relationship is working.

When reactions are 'coupled' to one another, this means that the energy released from the bonds of high-energy molecules is used to drive the reaction processes of many weaker molecular interactions or less energetic reactions. Energy coupling is a ubiquitous feature in biochemistry and plays a similar role in human chemistry. The classic example of free energy coupling in human life is that situation in which the work output of a successful and wealthy parent or grandparent drives or fuels the reactions of generations of offspring; which, in many cases, results in instances of side reaction nepotism.[25] To exemplify this intricate point, the energetic coupling effects related to fueling aspects of the high-energy adenosine triphosphate, ATP, molecule in living tissue will be discussed.

ATP is the universal energy currency of all living organisms. The structure of the ATP molecule consists of the base adenine bonded to a sugar called ribose, with three phosphate groups bonded to another carbon on the ribose. When the high-energy phosphorus oxygen *covalent bonds* (double electron bonds), three in total, between the phosphate groups are broken, energy is released. All living cells rely on ATP for the short-term storage of energy and the transfer or application of energy to

do work. In short, ATP is a multifunctional nucleotide that is the most important 'molecular currency' unit of intracellular energy transfer.

In living structures, the energy released by the breakdown of ATP is used by many enzymes and a multitude of cellular processes including biosynthesis, motility, and cell division.[26] The breakdown of ATP to adenosine diphosphate ADP, wherein one phosphate bond is broken, releases a respectively large amount of chemical free energy ΔG under normal biological conditions.[27] This is enough available energy to drive most typical endergonic reactions in the cell.



Adenosine triphosphate (ATP) $C_{10}H_{16}N_5O_{13}P_3$

In more detail, ATP consists of adenosine, itself composed of an adenine ring and a ribose sugar, and three phosphate groups. The phosphoryl groups, starting with the group closest to the ribose, are referred to as the alpha (α), beta (β), and gamma (γ) phosphates. ATP is highly soluble in water and is quite stabe in solutions between pH 6.8-7.4, but is rapidly hydrolyzed, meaning that it reacts with water, at extreme pH.[28]

The system of ATP and water under standard conditions and concentrations is extremely rich in chemical energy; the bond between the second and third phosphate groups is loosely said to be particularly high in energy. Strictly speaking, the bond itself is not high in energy, but energy is produced when the bond is broken and when water is allowed to react with the two products. Thus, energy is produced from the new bonds formed between ADP and water, and between phosphate and water.[29] The net change in enthalpy (system heat energy) at standard temperature and pressure of the decomposition of ATP into hydrated ADP and hydrated inorganic phosphate is -20.5 kJ per mole, with a change in the Gibbs free energy of -3.4 kJ per mole.[30] This large release in energy makes the decomposition of ATP in water extremely exergonic, and hence useful as a means for chemically storing energy.

In human molecular terms, the high-energy bonds attached to certain individuals contain enough energy to drive many nearby, less-energetic, endergonic human chemical reactions. Studies show, for example, that the number off *user bonds*, i.e.

energy absorbing bonds, and *giver bonds*, i.e. energy releasing bonds, varies per individual. Specifically, the number of user bonds a person holds in their personal network varies between 10 to 90 percent of their total bonds.[31] On average, in the typical person's bond network, 40 percent of those bonds will be of the endergonic variety. High I.Q. people, for instance, tend to cut off most user bonds, having no more than 10 percent of their total bonding quota as energy absorbing bonds.[31]

Endergonic bonds are typically qualified by statements such as 'I feel like X, Y, or Z, suck the life out of me'. Examples of people describing endergonic bonds are as follows: 'my guy friends are so frustrating, they absorb so much energy from me' (75%), 'some friends have too much drama; it's hard trying to make them happy all the time' (65%), 'my family is so demanding' (80%), 'my mother is always asking me for money' (80%), 'my ex-girlfriend was energy absorbing; I didn't waste my time arguing with anyone else' (20%), 'people I have to work with that I don't necessarily like' (40%), 'my family, especially my brother, keeps bring all their problems to me' (30%), 'in relationships, it's not always give-and-take, sometimes you end up giving more than you take' (60%), or 'certain people are mooches' (20%), etc. The numbers shown indicate the percent of endergonic bonds in the network of the person who made that statement.[32]

In sum, in human and biological situations endergonic relationships or reactions, that wouldn't normally go on their own, can be driven to work by coupling to stronger exergonic reactions or relationships, such as, e.g., nepotism or favoritisms, or more generally givers and takers. In nature, interestingly, for whatever reason, endergonic reactions and exergonic reactions are linked to each other. One cannot exist without the other.

Thermodynamics and evolution

We should now be able to see that human relationships are actually evolutions. In other words, reactions connected (coupled) to each other are what constitute life, and life as we know, evolves. In this direction, one of the first scientists to make a connection between evolution and entropy (also known as the *arrow of time*), was the biologist-philosopher Herbert Spencer who in 1880 observed that human systems have the unique ability to temporarily halt and even reverse the general tendency for entropy to increase by tapping energy flows in nature. He contended:

> "Humans have evolved in a pattern of increasing complexity, driven by *force*, the central principle of change."

The two driving forces involved in the process of chemical change (evolution), as we will show, are the enthalpic force ΔH and entropic force ΔS. The process of evolution, according to Spencer, both biological and social, ascribes to the second

law of thermodynamics, in that the struggle for existence is a struggle for available energy and resources. In his own words, 'evolution is a change (reaction) from a less coherent (disordered) form to a more coherent (ordered) form, consequent on the dissipation of energy (second law) and the integration of matter (combined law).'[33]

The first to make more a definitive connection between heat, evolution, work, entropy, and available energy (free energy) was the famous Austrian physicist Ludwig Boltzmann, the founder of statistical thermodynamics, who in 1886 stated the following:

> "The general struggle for existence of animate beings is not a struggle for raw materials – these, for organisms, are air, water and soil, all abundantly available – nor for energy, which exists in plenty in any body in the form of heat Q, but of a struggle for entropy S, which becomes available through the transition of energy from the hot sun to the cold earth."

In regards to a modern perspective of this statement by Boltzmann, according to researchers Eric Schneider and Dorian Sagan, from their 2005 book *Into the Cool: Energy Flow, Thermodynamics, and Life*, 'except for the term entropy, which is better replaced with Gibbs free energy G, Boltzmann's analysis is essentially modern.'

In 1907, German chemist and Nobelist Wilhelm Ostwald, in a manner similar to Boltzmann's views, incorporated thermodynamics into a general theory of economic development. Ostwald reasoned that energy was the sole universal generalization, in that energy processes underlie all circumstances. Based on this hypothesis, Ostwald theorized that for any event in the universe it is always possible to state an equation, between two time intervals, such as to quantify the difference between the energies that have disappeared and those newly arrived.[34] This, by no coincidence, is the methodology currently used to quantify energetic reactions in chemistry, namely the calculation of the before and after conditions in reactions.

In 1921, similar to Ostwald, James Johnstone, a Professor of Oceanography at the University of Liverpool, in his best-selling book *The Mechanism of Life in Relation to Modern Physical Theory*, was one of the first to elaborate on the famous 'entropy reduction paradox' associated with life. In short, life is characterized by low entropy, which is equivalent to the measure of the order or organization of a system; in nature, however, in the 1852 words of William Thomson (Lord Kelvin), 'there is at present in the material world a universal tendency to the dissipation of mechanical energy', meaning that the entropy of the universe tends to a maximum. Johnstone tells us that 'in living processes, the increase of entropy is retarded.' Moreover, in the words of famous mathematical chemist Alfred Lotka, who carefully

studied Johnstone's work, 'he points out that this is true, primarily, of plants; but that among animals also natural selection must work toward the weeding out of unnecessary and wasteful activities, and thus toward the conservation of free energy, or, what amounts to the same thing, toward retarding energy dissipation.'[35] Hence, in the beginning of the 20th century direct connections between natural selection, free energy, and entropy were in rudimentary formulation.

Similar to Ostwald's theories, in 1922 the English radiochemist and Nobelist Frederick Soddy applied the laws of thermodynamics to basic economic systems and devoted a significant portion of his professional career to a critique of the standard economic theory. Life, according to Soddy, 'derives the whole of its physical energy or power not from anything self-contained in living matter, but solely from the inanimate world. It is dependent for all necessities of its physical continuance upon the principles of the steam engine. The principles of ethics of all human conventions must not run counter to those thermodynamics.'[36] Soddy firmly positioned the fact that solar energy is the fuel that facilitates or empowers all life processes.

In 1926, similarly, the Russian-Ukrainian mineralogist and geochemist Vladimir Vernadsky, in his book *The Biosphere*, stated that 'living matter, as a whole, is a unique system which accumulates chemical free energy *G* in the biosphere by the transformation of solar radiation.'[37] Vernadsky was also the first to accurately state the connection between stability, equilibrium, evolution, free energy, and biological work:

> "Any system reaches a stable equilibrium when its free energy is reduced to a minimum under the given conditions; that is, when all work possible in these conditions is being produced."

All processes, according to Vernadsky, of both the biosphere and the crust, are determined by conditions of equilibrium in the mechanical system of which they are a part. Life, from this view point, is a global phenomenon in which the sun's energy is transformed into biospheric structure. Emphasizing photosynthetic growth of red and green bacteria, algae, and plants, Vernadsky saw these expressions of living matter as the *green fire* whose expansion, fed by the sun, pressured other beings into becoming more complex and more dispersed.[38]

The most oft-quoted reference to the fact that chemical free energy *G* tendencies control the evolutionary process was made by the Austrian physicist and Nobelist Erwin Schrödinger in his short 1944 book *What is Life*?; the vary same book that coincidently drove James Watson and Francis Crick to discover DNA. In this book, building on the work of Boltzmann and others, Schrödinger discussed the concept of how organisms 'feed on negative entropy', signified by the quantity '*–TS'*. Furthermore, as this was a book intended for the layperson, Schrödinger avoids a full

discussion of chemical free energy *G*, but states that: 'had he been writing for physicists, he would have made use of the concept of free energy; but judged that this concept might be difficult or confusing for the general audience.'[39] This presumption will not be made here.

Again, mathematically Gibbs free energy *G* is related to entropy *S* according to the following fundamental expression:

$$G = H - TS \qquad [4.9]$$

H is quantity called 'enthalpy' and is qualitatively defined as *the total heat energy of a system associated with a chemical change*.[40] Enthalpy is sometimes referred to as heat content, but this erroneously implies that the system stores energy as heat. Enthalpy is made up from the internal energy *U* of the system plus an external energy, which the system possesses by virtue of the fact that it occupies a volume of space at a specified pressure. In physical terms, the enthalpy change, symbolized by ΔH, can be regarded as the thermal energy transfer between the system and its surroundings in most chemical processes, such as, for example, the act of protein unfolding or a combustion reaction at constant temperature.[41]

Hence, from [4.9], if we wish to measure 'change' or evolution, which is symbolized by the Greek delta symbol Δ, we would have:

$$\Delta G = \Delta H - T\Delta S \qquad [4.11]$$

This expression [4.11], called the *Gibbs free energy equation*, in simple terms, is the basic reaction change relation energetically unifying all human interaction dynamics. This simple expression, used for systems in which species migrations are negligible, no external biasing forces act on the system, and in which only heat drives the system, can be used to predict the spontaneity of reactive or evolving systems of human molecules. Mathematically, the Gibbs free energy equation quantifies the three basic types of energies, namely free energy *G* (function energy), heat energy *H* (bond energy), and entropy energy *TS* (energy of ordering), in relation to the total internal energy *U* of a working body of reacting chemical species, e.g. a group of four friends, as these three quantities change from the *before state*, e.g. day one, to that of the *after state*, e.g. day three-hundred-and-sixty-five, during any chemical transformation or reaction evolution at constant temperature, pressure, and species. Again, the condition of constant species stipulates that migrations during the transformation are negligible; if species migrate, then chemical potential terms are used.[42]

The essentially rule for determining the reaction feasibility for all isothermal (constant-temperature) isobaric (constant-pressure) chemical reactions, is that the

value of the change in the Gibbs free energy ΔG for the reaction process in question is *negative* (meaning that energy is available for release), or specifically:

Value	Result
$\Delta G < 0$	Favored or spontaneous reaction
$\Delta G = 0$	Reversible or equilibrium reaction
$\Delta G > 0$	Dis-favored or non-spontaneous reaction

In other words, if a chemical reaction is energetically favored, namely that the change in free energy for the reaction is negative, the system will then spontaneously release chemical energy, freely in the form of useable work, spend its potential along the way, and do so without external constraint, and as such evolve towards a more stable electronic configuration. All isothermal, isobaric chemical reactions, human chemical reactions included, follow these three energy rules.

A point to note is that although a reaction may be energetically quantified as being 'spontaneous', the *speed of the spontaneity* also depends on kinetic factors, namely the rate of reaction, which depends on energetic barriers to equilibrium as well as stereochemical factors, such as the shape and fit of the molecules. So although the reaction may be regarded as being spontaneous, the rate of the reaction process may proceed very slow and may never actually reach their 'true equilibrium'. A dry piece of wood, for instance, in the presence of air is not at equilibrium: the *true equilibrium* mixture would consist of the oxidation products, carbon dioxide and ash. At ambient daily temperature, the reaction would take centuries to proceed; yet if the wood is lit, triggering it activation energy barrier, the thermodynamically preferred equilibrium is reached in a matter of minutes.

Enthalpy and bond energies

In chemistry, the enthalpy change ΔH of a chemical process is quantitatively related to chemical bond energy. In addition, all chemical bonds, human bonds included, are quantum electromagnetic in composition. Moreover, according to great Scottish physicist James Maxwell, the founder of electromagnetic theory, all 'electromagnetic fields, even in empty space, hold energy.' Thus, electric currents and the magnetic fields associated with them carry kinetic energy like the moving parts of a mechanical system. In sum, electric fields hold potential energy, like mechanical springs.[43] Subsequently, all human bonds hold energy.

The quantum field particle or messenger that carriers the electromagnetic force is called the photon, symbolized by γ (gamma).[44] To exemplify this definition, from the popular essay 'Chemistry – a Central Pillar of Human Culture', by Sason Shaik, a chemistry professor of Hebrew University, we find 'the accumulation of chemical

knowledge has taught us, however slowly, that behind the spectrum of human traits there lie chemical mechanisms of molecular motions and mutual interactions of molecules with each other and with the surrounding photonic field.'[45] To create dynamics, the photonic field 'interacts' with valence shell electrons of the atoms and molecules that constitute life in such a manner so as to mediate chemical change. Photon-electron-interactions result to create molecular movements and bonding reconfigurations. Dynamic molecular movements, atomic exchanges, and bonding rearrangements are what characterize evolution.

Along these lines, when polled, people agree absolutely that there is such a construct as a *human chemical bond* between people (although no chemist has ever actually defined what this is).[46] Moreover, people agree with the hypothesis that there exists quantifiable amounts of measurable energy caught up or found within human chemical bonds, varying per relationship.[47] Carbon-carbon bonds, *C*-*C*, to give a rough comparison, have energies of about 50 atto-joules per molecule. The energy contents of human chemical bonds, e.g. $Mx \equiv Fy$, will be discussed in chapter thirteen.

Interpersonally, humans will tend to have the majority of their bonding energies contained, utilized, or found within a dozen or so dominate bondings. When asked, for example, to make a list of people whose death would leave us truly devastated, we typically list ten to fifteen names, with the average being twelve people.[48] Moreover, sociologists estimate that within the average person's social network, i.e. friends, family, work associates, acquaintances, etc., there exists about 200 people; furthermore, it is estimated that we know 300 to 5,000 people by name.[49] Thus, as an estimate, the average person has their total quota of bond energy divided among several thousand interpersonal human chemical bonds.

In addition, so strong is the belief that human bonds are inherently chemical bonds, that within the last few years, high school chemistry teachers have begun assigning internet-based homework assignments in which students are told to use chemical bonding theories to explain the ebb and flow of conflict and collaboration of human relations in terms of manifestations of chemical bonding effects.[50] In 2002, at New Trier high school, in Illinois, for instance, students were asked to consider how elements and chemical species chemically bond or conflict, and to think about how these polar opposite processes of bonding and conflicting play out in life, specifically in human relationships.

In this assignment, it was argued that by studying how elements interact and bond to each other, students might learn about how humans interact and bond with each other. Suggestive queries were 'how does electrical attraction promote bonding in certain species,' or 'how do incongruent physical shapes between compounds can promote debonding,' and 'why does the famed *opposites attract* scenario occurs in chemistry?', etc. One interesting suggestion was to try to determine what kind of hypothetical chemical bond Romeo and Juliet had in their high-energy relationship.

Interestingly, in regards to this last question, even Shakespeare himself had ideas about human chemical bonding. In particular, Shakespeare assumed the existence of an external force that induces amorous attraction.[51]

Social psychologists, likewise, over the last half a century, have been building theories on how humans invest energy in evolving relationship bonds. In the 1779 book *The Making and Breaking of Affectional Bonds*, developmental psychologist John Bowlby built on Sigmund Freud's 1915 psycho-hydraulic 'energy model' of instinct and its vicissitudes and Konrad Lorenz's 1950 theory of 'reaction specific energy', such as if found in imprinting, to build a theory of human affectional bonding. Specifically, using Freud's theory in which a person holds reservoirs and accumulations of 'energy' in his or her psychological construct, in relation to past attachments, and Lorenz's interesting conception of reaction specific energy, in which each mental reservoir is conceived of as being controlled by a release valve or innate release mechanism that can be opened by the perception of the appropriate energetic stimulus so that the reaction energy can be discharged in the performance of the specific behavior, Bowlby argued that, through these processes, affectional bonds result or are created that keep people in proximity to one another.[52]

Similarily, in the 2001 meta-analysis book *Ontogeny of Human Bonding Systems*, psychologists Warren Miller and Joseph Rodgers step through the various evolutionary, psychological, and neurological bonding theories and argue that goals determine bonding investment criteria. They point out that each species, in a system, is faced with survival and reproductive pressures. These system pressures, according to Miller and Rodgers, determine how a person uniquely invests energy, resources, and time in a particular bond.[53] In short, they postulate that reactionary and evolutionary mechanisms, which establish and maintain bonding between dyadic partners, represent correlated phenotypes, i.e. physical properties of an organism that are produced by the interaction of the genotype and the environment, that result from the interaction between social selection and genetic effects.

In thermochemistry, *bond energy*, symbolized by E_B, is the amount of energy associated with a electromagnetic bond between chemical species.[54] Bond energy, in addition, quantifies as a measure of the 'stability' of a molecular structure, e.g. the structure of two friends. To a certain approximation, which depends upon the nature of the system, the *bond dissociation energy*, i.e. the energy required to break a particular bond in a molecular relationship, is a measure of the enthalpy change ΔH for that reaction. In solids, liquids, and for chemical reactions occurring over substrate, as human life does, bond dissociation energies are affected by neighboring molecules.[55] In a typical marriage bond, for example, the bond dissociation energy of that union is dependent on secondary attachments, such as the views of family and friends.

In this manner, we will postulate that enthalpy, in human life, mathematically correlates to both the development of and, in other cases, the dissolution of human

chemical bonds. To review, the enthalpy change ΔH measures the total amount of energy either released from or absorbed into a chemical bond during a *chemical reaction*.[56] Said another way, an observable enthalpy change during any chemical reaction occurs as a result of either making, breaking, or distorting bonds between molecules.[41] This is analogous to Bowlby's attachment theories of the making and breaking of affectional bonds throughout a person's development.

To summarize, in life, enthalpy change is related to both the formation of evolving interpersonal bonds and to the dissolution of non-evolving interpersonal bonds. Mathematically, in terms of absorbed or released bond-energies, the enthalpy change for a chemical reaction can be measured according to following expression:[57]

$$\Delta H = \Sigma E_{BB} - \Sigma E_{BF} \qquad [4.12]$$

Expression [4.12] tells us that the change in the enthalpy for a given chemical reaction is equal to the difference between the sum of the energy contents of the bonds broken E_{BB}, over the course of the reaction, minus the sum of the energy contents of the bonds formed E_{BF}, during the reaction. Related to expression [4.12] is the term *bond strength*, which is the degree to which chemical species are attached; a measure which varies per relationship.[58]

Substrate and catalysts

Human bonding is an immediately recognizable phenomenon. Most can easily categorize one's own personal bonds to other people, in terms of the quantifiers such as strong, intermediate, weak, ambivalent, non-desirable, or draining, etc. The energetics associated with human bonds with specific reference to related molecular interactions such as dietary processes, clothing, wealth, land, etc., are not so easy to quantify. Thus far, we have tentatively divided up the mass of the biosphere, with respect to human chemical reactions, into *reactive matter*, e.g. a hot single human, *substrate matter*, e.g. land, *catalytic matter*, e.g. a television, and *nutritive matter*, e.g. an apple.

A *catalyst*, technically, is a molecular substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.[54] A *substrate*, technically, is a molecular substance that is affected by the action of a catalyst; for example, the substance upon which an enzyme acts in a biochemical reaction.[54] In biology, a 'substrate' is the natural environment in which an organism lives, or the surface or medium on which an organism grows or is attached.[59] Thermoeconomist James Reiss, from the 1994 book *Thermodynamics and Economics*, states that 'catalysts exist not only at the molecular level, but virtually every tool built by man can be called a catalyst. Hammer, screwdrivers, and

wrenches are all catalysts designed for specific purposes and are tools which perform functions incredibly more efficient than could human hands do alone.'

To elaborate further, American chemical engineer Scott Fogler, in his 1992 *Elements of Chemical Reaction Engineering*, uses a man who incites a riot but then ducks out before the situation turns violent as an example of a human catalyst.[60] In this case, the man is the catalyst, the riot site is the substrate, and the transforming or revolting group of people constitutes an isomerization reaction, approximately, or more appropriately a transformation reaction:

$$A \xrightarrow{catalyst} B \qquad [4.13]$$

In other words, molecular structure A is the pre-revolutionary social collective, B is the post-revolutionary social collective, and the human catalyst is drawn over the reaction arrow. In this point of view, Gavrilo Princip can be considered the catalyst of WWI.

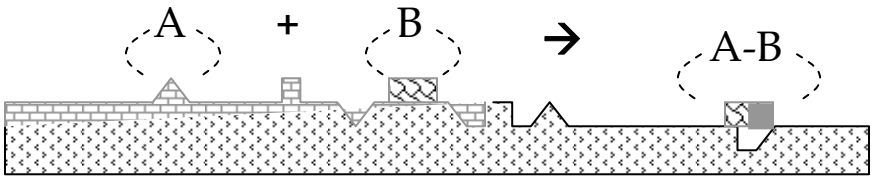
In recent years, fields such professional sports, business, and consulting, there has been a push to put together person-specific groups with good 'team chemistry'. In software consulting, in particular, 'project chemistry' is a highly sought after quality. Certain people are often selectively added to project teams to serve as a catalyst for the group. Consultants Tom DeMarco and Timothy Lister, in their 1987 book *Peopleware,* for example, reason that a person who functions as a 'catalyst' in a project group is important because projects tend to always be in a state of flux; thus if someone has the skill-sets to energize a group, the project will be completed quicker and more efficiently. These catalyst people themselves may not necessarily the most productive, and would not necessarily be better on their own than someone else, but in a group setting they can keep the group moving. Someone who can help a project 'jell' is worth two people who just do work.

Catalysts, in chemistry, whether a person or a quantity of matter, tend to encourage or speed chemical reactions by lowering the activation energy barrier of the reaction. The *activation energy*, symbolized by E_A, is the minimum energy required for a chemical reaction to take place.[54] The essential roll of a catalyst is that it provides an alternative pathway by which the reaction can proceed, in which the activation energy E_A for the reaction is lower. At the molecular level, the catalyst affects the ordering process of the reactants; the reaction, in turn, requires less driving energy to overcome the natural dissipative effects of disorder and randomness, as per the second law. It thus increases the rate at which the reaction comes to equilibrium, although it does not alter the position of the equilibrium.[54] Generally, a *positive catalyst* is the term used for a substance that increases a reaction rate, whereas *negative catalysts* function to slow down reactions.

A related term is *catalysis*, defined as is a chemical process in which a relatively small amount of foreign material, called a catalyst, augments a chemical reaction

without itself being consumed.[61] In most cases of catalysis, a given set of reactants could react in two or more ways. The degree to which just one of the possible reactions is favored over the other is called *selectivity*.[61] The phrase 'catalysis' was coined by the Swedish chemist Jöns Jakob Berzelius in 1835 who was the first to note that certain chemicals speed up a reaction. Other early chemists involved in catalysis were Alexander Mitscherlich who in 1831 referred to 'contact processes' and Johann Wolfgang Döbereiner who spoke of 'contact action'.[62] The earliest use of catalysts occurred in the first millennium BC, where it was noted in the making of wine, cheese, and bread that it was necessary to add small amounts of the previous batch to make the current batch.[63]

In 1928, in a landmark contribution to catalytic theory, English chemist Hugh Taylor suggested that a catalyzed chemical reaction is not catalyzed over the entire solid surface of the catalyst but only at certain 'active sites' or centers.[64] Taylor visualized active sites as unsaturated atoms or available binding regions in the solid that resulted from topological features such as surface irregularities, dislocations, edges of crystals, or cracks along grain boundaries, etc. Thus, an *active site* or binding site is a point on a catalytic reactive surface that can form strong chemical bonds with an absorbent molecule.[65] The conceptual model of two species *A* and *B,* on two different sites, reacting to form an *A-B* complex on a new attachment site is shown below:



Vacant and occupied bonding sites

The simplest and most common example to illustrate these attachment and reaction dynamics is the *Haber process* developed in 1908 by German chemist Fritz Haber. In the Haber process, nitrogen N_2 and hydrogen H_2 molecules floating about in the gas phase are forced to react over a sheet of iron Fe^{3+} imbedded with aluminum oxide Al_2O_3 and potassium oxide K_2O. The iron sheet functions as a surface catalyst, having certain active sites on its surface, according to which the air-bound hydrogen and nitrogen molecules are attracted. At high temperatures they float down and attach to it. Once attached, the two molecules react favorably with each other to form ammonia NH_3, a two-element molecule:

$$N_2 + 3H_2 \rightarrow 2NH_3 \qquad [4.14]$$

In terms of human substrate, by comparison, the earth's crust is five percent iron and of the oxides embedded in it sixteen percent are aluminum oxides and three percent are potassium oxides.[66] Subsequently, the Haber process serves as a basic substrate model of human molecular attached reaction life on earth.[67]

Similar to this example is the reaction life of birds. The molecular structure of a bird is very near to that of a reptile of which they evolved from. Chemically, we can think of a bird as being approximately a twenty-three-element molecule.[68] The gray shrike, for example, is a bird that lives in the Negev Desert of Israel. Just before the start of breading season, male shrikes begin amassing caches of edible prey, such as snails, and other useful objects, such as feathers and pieces of cloth, in numbers ranging from 90 to 120. They impale these items on thorns and other pointed projections within their territory. Females look over the available males and prefer to mate with those having the largest caches.[69] Moreover, in one experiment, when biologist Reuven Yosef arbitrarily removed portions of some males' caches and added edible objects to others, females shifted to the attachment sites of the males with the larger bounties.[70] Females avoided entirely males without resources, consigning them to bachelorhood.

The naïve person would likely argue that humans are moral creatures who use reason and would never act like mindless birds. This, however, is not the case. The bird is a molecule, each human is a molecule, and molecules will invariably tend, i.e. are forced, to migrate towards the most energetically stable configurations.

In general, in the biological world, wherever females show a mating preference, the male's resources, which usually relate to preferred attachment sites, are often the key criterion. In human reaction terms, for example, it is well known that women tend to actively select for resources and intelligence in potential mates, whereas men tend to actively select for youth and beauty in potential mates.[69] Men, being well aware of this female selection pressure, will therefore have an active tendency to strive to bond strongly to society via an occupational attachment site. Women, being more flexible and mobile in this respect, will spend more time maintaining their youth and beauty, and as such will have a greater tendency to bond to successful, occupationally-attractive men and their unique attachment sites. Studies of personal advertisements, for example, show that female advertisers seek financial resources roughly eleven times as often as male advertisers do.[71]

These sex-specific tendencies, in which the male, on average, expends more energy in bonding to attachment sites in society, whereas women expend more energy in bonding or attaching to a man's attachment site, are resultant functions of system constraints, namely that human species react in an air-vapor environment. In general, to create a living molecule, such as a human baby, there needs to be a liquid medium available for its initial development or assembly phase, which in the human case is an intrauterine environment. This fact pre-assigns to each sex, function specific bonding tendencies, to which each excels. In liquid environments, such as

in rivers, lakes, or in the ocean, conversely, there is no need to have an intrauterine environment. In these situations, the sex roles are reversed. The females are larger in structural size and more dominant. Females lay their eggs on the attachment sites of the ocean bed floor in numerous places; the males then attach to these egg laying sites and incubate the eggs, while the females go on their way. In this environment, the females, in a sense, impregnate the males and then leave them.

To summarize attachment tendencies in human life, according to interpersonal attraction researchers Kevin Hogan and Mary Lee Labay, 'the first filter women use to evaluate a man at the unconscious level is his probable access to resources', which translates to occupational viability, money, advanced education, ambition, work ethics, and status in the peer group.[72] Likewise, according to Hogan and Labay, 'the first unconscious filter a man has when evaluating a woman is physical attractiveness', which correlates to quantities such as health, ability to reproduce, symmetry, waste-to-hip ratio, averageness, complexion, etc. The basic male evolutionary tendency, at some deep unconscious level, according to these researchers, is 'a desire to have sex with a woman who is healthy.' Women, conversely, want to bond to 'a man at work'.[72] These assignments, of course, are highly stereotypical; however, even in modern times, there are actually some men who are turned off by a women who has a job.

Thus, approximately, successful occupational attachment, as well as related resources, etc., will be classified as a type of substrate attachment, approximately. In aquatic environments, by comparison, the material used on the bottom of a tank or of the ocean bed is called 'substrate', a factor which affects water chemistry, filtration, and the well-being of the aquarium's inhabitants, and is also an important part of the aquarium's aesthetic appeal. The appropriate substrate depends on the type of aquarium.[73] Likewise, in marine biology, the earthy material that exists in the bottom of a marine habitat, such as dirt, rocks, sand, minerals, or gravel, etc., is called 'substrate'. Humans, to note, evolved from prehistoric land-walking fish about 0.7 billion years ago.[74]

The relationships between matter and human chemical reactions and those such as sustenance, metabolism, or homeostasis, etc., to note are not easily discernable. To simplify our calculations, then, as a first approximation, we will also, in some cases, classify dietary processes as nutritive substrate interactions. Sustenance can be thought of as a form of nutritive catalytic activity. In chemistry, substrate interactions are usually neglected in thermodynamic calculations, being that they do not significantly affect the energetics associated with chemical reactions between species. In other words, two people will have the same probability of reacting, e.g. falling love, on any specific day, regardless of what they had for breakfast. In the long term, however, dietary factors, of course, will affect a person's reactivity, e.g. fit-looking (reactive), unfit-looking (unreactive).

Substrate interactions only function to either speed up or slow down the pace of a reaction by changing or modifying what is called the activation energy barrier. The *activation energy*, symbolized by E_A, to review, is the minimum energy required for a chemical reaction to take place.[54]

Collision theory

Connected to the definition of activation energy is collision theory. In chemistry, *collision theory* is a theory proposed in 1916 by Max Trautz and William Lewis that qualitatively explains how chemical reactions occur and why reaction rates differ for different reactions.[75] Collision theory, in simple terms, is based on the assumption that for a reaction to occur it is necessary for the reacting species, i.e. atoms or molecules, to come together or collide with one another.[76]

Not all collisions, however, bring about chemical change. A collision will be effective in producing chemical change only if the species brought together possess a certain minimum value of internal energy U, equal to the activation energy E_A of the reaction.[76] These are called *effective collisions* and result in the transformation of reactant molecules into products.[77] In human terms, a pair that collides, dates, and then transforms into a married couple, would be an example of an effective collision.

Effective collisions occur as a consequence of the fact that only a fraction of the molecules have sufficient energy and the right orientation at the moment of impact to break the existing bonds and form new bonds. In other words, not only must the colliding species posses certain energies, but they must also be oriented in a manner favorable to the necessary rearrangement of bonds, atoms, and electrons involved. Thus, according to collision theory, the rate at which a chemical reaction proceeds is equal to the frequency of effective collisions.

In human reaction terms, collision theory applies absolutely; however, the visual conception of collisions between human molecules, moving over substrate, requires a bit of discussion, as well as the development of new terminologies. In other words, collision theory was developed originally for reactions between atoms and molecules in the gas or liquid phase. Subsequently, applying it to human reactions occurring over substrate will require further development. In chapter nine, in particular, a theory of human molecular reaction orbitals, i.e. probabilistic activity orbitals, will be developed, such that, from a time-accelerated point of view, collisions of human probability orbitals, oriented in various unique energetic manners, will play a significant role in determining the outcome of basic human molecular collisions.

To summarize, collision theory supposes that molecular collisions must always precede a chemical reaction.[78] To give examples of frequency, in normal gas phase systems each molecule hits other molecules at a rate of 10^9 times per second in bimolecular collisions, whereas trimolecular collisions occur at a rate of 10^5 per second. In liquid phase systems, the collision rates are less frequent than this. In

human molecular system, i.e. air-vapor phase, substrate-attached systems, collision rates are more difficult to estimate; moreover there are social collisions as well as intimate collisions to consider, among others. The 2004 Award-winning film *Crash* gives an excellent overview of the intricacies involved social collisions. In the film, several characters, living in Los Angeles, collide during an eventful 36 hour period in which car accidents, shootings, and carjackings bring them together. Most of the characters depicted in the film are racially prejudiced in some way and become involved in conflicts which force them to examine their own prejudices. Through these characters' interactions, the film attempts to depict and examine not only racial tension but the distance between strangers in America.[79]

Along these lines, we see that collision theory can also be interpreted in terms of the *force of the collision*, namely that the likelihood of reaction upon the collision of two molecules must certainly be affected by the force of the collision. Forceful collisions are much more apt to lead to the breaking and making of chemical bonds than are less forceful collisions. The film *Crash*, for example, a self-described 'passion piece' for Canadian screen-writer Paul Haggis, was inspired by a real life incident where Haggis' Porsche was *forcefully* carjacked outside a video store on Wilshire Boulevard in Los Angeles in 1991.[80] This is an example of a real-life social bimolecular effective collision, between two human molecules, resulting in a human chemical reaction (life transformation), resultant change (moviegoers moved by the film), and work output (script writing).

In human romantic collisions, we note that molecules with less than sufficient energy to exert this force will not react, whereas molecules with a higher energy than this minimum can react.[78] Along these lines, statistically it is known that 28 percent of couples fall in love at first site.[81] In these love-at-first sight collisions, out of the many collisions that didn't activate, a situation occurred in which one or both of the reactant pairs, owing to necessary and sufficient internal energy requirements, at the moment of collision, e.g. looks, humor, class, education, occupation (substrate attachment), fitness, wealth, status, integrity, etc., exerted a *force* on the other, so as to create an effective collision. In other interactive situations, collisions may be more subtle; yet the chemistry can be felt. One study, for example, found that 40 percent of single adults say that they know whether or not they have chemistry either instantly or within 15 minutes of meeting someone.[82]

Species concentration is also a factor in collision theory. In short, an increase in concentration of reactants increases the collision frequency between the reactants; subsequently, the effective collision frequency also increases. In other words, at higher species concentrations, more collisions will occur, resulting in more reactions. In human molecular terms, for example, more effective collisions, and subsequent reactions, will occur in a packed nightclub, than will occur in a dead nightclub.

Temperature is also a factor in collision theory. Essentially, an increase in temperature increases the average speed of the reactant molecules, the number or

frequency of collisions, and fraction of molecules having kinetic energy higher than the activation energy. Resultantly, the effective collision frequency increases. In human terms, as an example, one is more likely either get pregnant or get someone pregnant during spring break, i.e. a system at warmer temperatures, as compared to winter break, i.e. a system at colder temperatures. Population densities confirm this: temperate climates, on average, are more populated, i.e. have yielded more product of a diversified variety, than polar climates.[83] There are more varieties of species in the tropics, for example, than anywhere else on earth.

To note, temperature *T,* pressure *P*, and volume *V* in human system terms are intricate topics, requiring a great deal of mental thought and discussion. There are those who will adamantly argue that the inherent 'heat' of human attraction, the 'pressure' of stressed or tense situations, or the 'volume' of territory, for instance, are only verbal metaphors, having nothing whatsoever to do with physics; and that they are not quantifiable by the standard gauges of *thermometers*, i.e. devices that measure temperature or temperature gradient, *barometers*, i.e. instruments used to measure atmospheric pressure, or *indicator diagrams*, i.e. devices that measure pressure and volume changes in working systems. The inherent difficulty lies in the fact that basic human energies and pressures are smaller in comparison to atmospheric energies and pressures. As such, no one has yet built agreed upon human thermodynamic instruments, to adequately quantify pressure (the force of neighboring molecules) and temperature (the energy transfer effect of neighboring molecules) in human systems. This is a topic of further inquiry.

In any event, in sum, chemical reaction rates tend to increase with both reactant concentration and with system temperature. In biological terms, it is well documented that the varieties of life increase, i.e. reaction rate is faster, in warmer climates than as compared to colder climates. Similarly, the first to note a correlation between reaction rate and biological species concentration was German zoologist Carl Semper who, in 1881, observed that the multiplication of organisms in small ponds diminished as the number of individuals increased.[84] Later experiments confirmed Semper's concentration generalizations with fruit flies and fowls in other environments.[85]

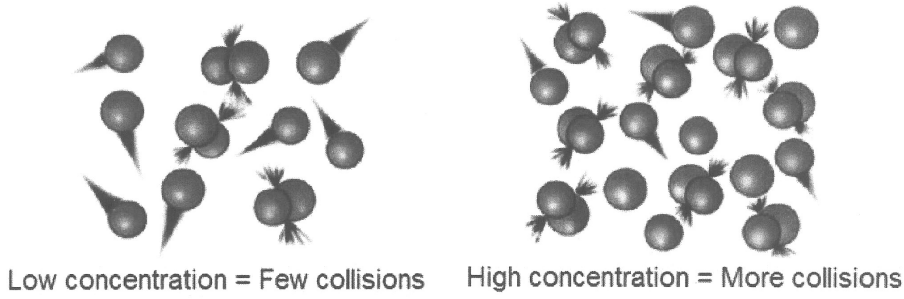
Assuming an initial stage species *A* and a final stage species *B*, while neglecting a large number of intermediate reaction evolutions, these types of overall system evolution reactions can be approximated as follows:

$$A \rightarrow B \qquad [4.15]$$

Thus, using Semper's terminology, as the number of individuals, or concentration of *B,* increases, the multiplication, or reaction rate, of organisms, in small ponds diminishes;

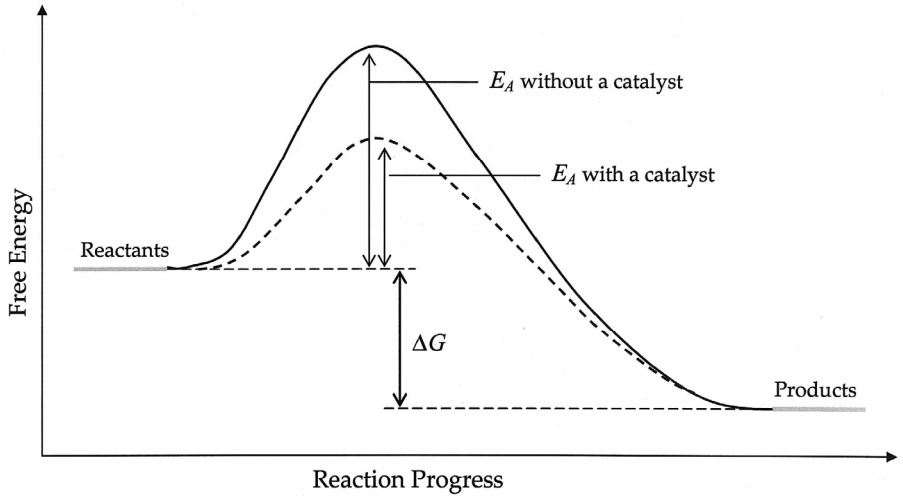
$$Rate \propto \frac{1}{[B]} \qquad [4.16]$$

In this direction, the earliest collision theories regarded reactant molecules as hard spheres such that a collision was considered to have occurred when the distance *d* between the centers of the two molecules was equal to the sum of their radii.[75] In the gas phase, as discussed, an increase in concentration of the moving reactant species increases the collision frequency between the reactants, thus increasing the number of effective collisions or 'conversion encounters', which thus results to increase reaction rate, as shown below:



Collision scenarios in human reaction life are similar, only here the collisions occur over substrate and are dynamic and non-reversible.[86] If, for example, a twenty-five-thousand person capacity high school begins the year with a thousand students, i.e. a low concentration of students, there will be relatively fewer reactions between students than as compared to if the school was at full-capacity. If then, by chance, a new batch of one-thousand students is suddenly introduced into the existing school system, due to possibly the closing of a neighboring school, then we should expect the reaction rate of the system to increase according to collision theory.

In a typical chemical reaction, as described, the reactant species come together in a collisional manner. During the collision, many chemical bonds are stretched, broken, and or formed in the products of the reaction. In human life, as an example, during the process of courtship and marriage, previous family, friendship, occupational, and social bonds, etc., will invariably be either adjusted or broken, in a significant manner, and new ones will be formed, so to fuse the requisite marriage bonds with the new developing family. During these collisional periods, the energy of the system increases to a maximum, at a point or energy height called the 'potential barrier' that separates the two potential energy minimas, and then decreases to the energy of the products, as detailed below:



To explain *collision* in biological terms, we will refer to Alfred Lotka's famous 1922 paper 'Natural Selection as a Physical Principle'. In this paper, Lotka defines *survival of the fittest* as persistence of stable forms. Furthermore, after a discussion of the first and second laws of thermodynamics, he defines *evolution* as a change in the distribution of matter among the components of a physical system.[87] Next, Lotka states that living organisms are little Carnot energy transformers, which, from a second perspective, according to Lotka, can be thought of as tiny *material particles* in larger statistical systems. 'Real phenomena,' according to Lotka, 'are irreversible; and in particular, trigger action, which plays so important a role in the process of life, is a typical irreversible process, which releases available energy from a false equilibrium.' The term *trigger action* is used, by Lotka, as an overarching label to categorize sensory inputs, and the correlative nervous system processing, that trigger a significant energetic response.

Lotka approximates that organic evolution involves two types of energy transformers: accumulators (plants) and engines (animals). Moreover, Lotka argues that the similarity of the units of individual organisms invites a statistical treatment, in which the units are not just simple material particles, from the ordinary reversible elastic collisions of kinetic theory, e.g. the pool table analogy, collisions in which action and reaction are equal; but rather, the units of biological statistical mechanics are energy transformers subject to inelastic *irreversible collisions* of a peculiar type, i.e. collisions in which trigger action is the dominate feature.[86] For example, according to Lotka, 'when the beast of prey *A* sights its quarry *B*, the latter may be said to enter the field of influence of *A*, and, in that sense, to *collide* with *A*. The energy that enters the eye of *A* in these circumstances may be insignificant, but it is enough to *work* the relay, to release the energy for the fatal encounter.'

Human collisions actuate according to similar principles. Romantic collisions, of course, the most interesting collisions in human chemistry and immensely more

complicated in mechanism, than atomic collisions. Stories abound, for instance, in which a spouse recalls having first had their mate enter their 'field of vision' and knowing right then and there that he or she was the one for them. From a day-by-day perspective, we may not be directly inclined to think of human interactions as collisions, per se; but when human life is viewed at a sped-up pace, most can easily look back and remember encounters or collisions with certain people that resultantly functioned to change one's life forever.

Island example

A very simplistic example to illustrate these concepts would be to suppose we have a hypothetical deserted island on which two people live: one man and one woman. Thermodynamically, the island would be considered a *closed system*, approximately. This means technically that energy can flow through the boundary of the system, i.e. the perimeter of the island, but not reactive matter, such as another human. In our situation, this means that no reactive human species may enter or leave the system; the only matter to cross the system boundary we take into account is that which would substantially change the internal energy U of the system. One nitrogen molecule N_2 crossing the system boundary, for example, would not effect energy calculations substantially, whereas one unattached 'single' male entering the system would, i.e. referring specifically to sexual selection, relationship dynamics, work-output tendencies.

Hence, on our hypothetical island, chemically speaking we have a woman Fy bonded into a working relationship with a man who we will call man-one Mx_1. We symbolize the bonded relationship by $Fy{\equiv}Mx_1$. Furthermore, let us suppose that the quantity of *bond energy* caught up in their working bond is 70 units. Now let us introduce man-two Mx_2 into the island system. The system, after the man is added, is now considered to be thermodynamically closed. By adding this second reactive human molecule into this closed island system, technically, we have functioned to set the thermodynamic system out of equilibrium. Subsequently, a new accelerated reactive evolution will take place, directed invariably towards a new equilibrium point of dynamic stability. The day the second man is introduced into the island will be called our 'initial state'. We will then let the reaction proceed for a number of years until we reach a specific day, which will be termed our 'final state'. During these reactive years, no new reactive persons will enter or leave.

Next, let us suppose that if this woman were to form a new bond with man-two that the quantity of their new unique *bond energy* in their newly formed working bond would be 100 units; meaning that bond $Fy{\equiv}Mx_2$ would be inherently stronger than bond $Fy{\equiv}Mx_1$. Thus, hypothetically, if this woman were to break-up her existing relationship, i.e. to leave man-one, so to form a new working relationship with man-two, we would have the following human chemical reaction:

$$FyMx_1 + Mx_2 \rightarrow Mx_1 + FyMx_2 \qquad [4.17]$$

Using [4.12], then, the enthalpy change ΔH for this reaction process would be:

$$\Delta H = \Sigma E_{BB} - \Sigma E_{BF} = 70 - 100 = -30 \text{ (energy units)} \qquad [4.18]$$

The negative sign tells us that the reaction [4.17] was *exothermic*, meaning that energy, in the form of heat, was released from the working-body, i.e. from the interactions and dynamics of the three relationships, some remaining in the system as 'bound energy' or heat interaction dissipation, and some going to external productive work, i.e. 'free energy'.

A significant point to note, however, is that enthalpy calculations alone do not predetermine if a reaction will occur, entropy factors must also be included in the calculation. In other words, for example, the women may be physically hot for the new man, but if the final entropy conditions S_F in their new potential relationship are too disordered as compared to her life with man one S_I, than the reaction may not proceed if the value of entropy change is not favorable:

$$\Delta S = S_F - S_I \qquad [4.19]$$

To remedy these competing tendencies, the free energy [4.11] of the reaction, which takes into account the driving forces of enthalpy and entropy, is calculated. If the change in the quantity of Gibbs free energy is negative, the reaction will proceed spontaneously. Some of this energy, naturally, will go to productive activity, i.e. 'work', the rest will remain *bound* in the system, e.g. 'play' energy or that lost to 'dissipation', i.e. frictional losses, among other venues of energy use or movement. Conversely, should the sign be positive, this would indicate an *endothermic* reaction, indicating energy absorption.

These energy categories, to clarify, are only first crude approximations; yet, they align well with British writer James Howell's famous 1659 proverb 'all work and no play makes Jack a dull boy' (life in short). In other words, in terms of energy expenditures, the majority of life involves either work or play; but there are also irreversible energy losses that don't go into work or play. Dividing human energy expenditures into three distinct categories is a rather difficult effort, and only done at the beginner level here. Nevertheless, we will try to follow various historical assignments here as first approximations. In equation [4.11], for example, the change in the Gibbs free energy ΔG, by definition, accounts for the portion of enthalpy heat energy ΔH that is transformed into *work energy*. The change in the entropy ΔS, likewise, accounts for the portion of this enthalpy heat energy (total energy) that is transformed into other variations of internal bound energy not available to be used to

do useful work; primarily the work the molecules do on each other, i.e. interactive *dissipation energy*, which may possibly include collisional or interpersonal dynamics such as tensions, arguments, frictions, conflicts, misalignments, etc. American thermodynamicists Schneider and Sagan, for instance, in their 2005 *Energy Flow, Thermodynamics, and Life,* define entropy as 'a measure of the one-way conversion of energy into heat and friction'; which, in human life, may correlate as resistances to productive work output. To elaborate on these energy distinctions, from the famous 1878 encyclopedia Britannica article written by the great James Maxwell:

> "Dissipated energy is energy which we cannot lay hold of and direct at pleasure."

Maxwell goes on to clarify that this dissipation energy is 'the energy of the confused agitation of molecules which we call heat.' He then states, 'confusion, like the correlative term order, is not a property of material things in themselves, but only in relation to the mind which perceives them … It is only to a being in the intermediate stage, who can lay hold of some forms of energy while others elude his grasp, that energy appears to be passing inevitably from the available to the dissipated state.'

On Maxwell's definition, we will postulate that any type of human energy expenditure that does not go directly into useful productive external work-output (or that possibly which is directed at pleasure), will be accounted for by the change in the entropy ΔS term or differentially by $-TS$. In a more thorough analysis, however, every factor that effects the internal energy of the system, such as external forces, would be accounted for and differential Gibbs free energy equation would become more complicated than [4.11]. This energy distinction, to note, is far from exact; these are preliminary assignments, and should be thought of as tentative approximations.

Gibbs free energy theories

In continuation with these examples, in 1965 metallurgical engineer Jack Kirkaldy, in his *Biophysical Journal* article 'Thermodynamics of the Human Brain', postulated a first-ever Gibbs free energy theory of consciousness. In this article, Kirkaldy argues that the human brain may be regarded as an irreversible thermodynamic system, which is constrained by a fixed inflow of free energy G in the form of chemical nourishment from within the body, and information from the outside environment.[88] Kirkaldy reminds us that 'biological subsystems are sufficiently circumscribed by their local boundary conditions such that their course of development can be understood as a stability-seeking path in a subsurface of the master potential for the earth system.'

The word 'potential' used here, is *chemical potential*, symbolized by μ (mu), as was introduced in 1876 by Gibbs, which he defined as follows:

> If to any homogeneous mass in a state of hydrostatic stress we suppose an infinitesimal quantity of any substance to be added, the mass remaining homogeneous and its entropy and volume remaining unchanged, the increase of the energy of the mass divided by the quantity of the substance added is the *potential* for that substance in the mass considered.

In addition, Gibbs noted that for the purposes of this definition, any chemical element or combination of elements, such as chemical species in a working body, in given proportions may be considered a substance, whether capable or not of existing by itself as a homogeneous body.[89] Essentially, the chemical potential for an individual chemical species is measured in terms of how it changes the internal energy of the system to which it is introduced. The general rule with respect to migrations of species, into or out of the system, is that chemical species move from regions of high chemical potential to regions of low chemical potential.[90] In human life, this actuates to the tendency in which human species, on average, each strives to realize his or her own greatest potential. They do this, for example, by physically locating themselves in the most optimal regions, ones with abundant resources and career opportunities that align to their skill sets. In other words, at the end of well-lived life, a person's potential should be completely spent, and thus be in a region of low chemical potential, such as retirement in Florida.

By modifying expression [4.11], with the addition of a chemical potential term, Gibbs also showed very clearly how chemical thermodynamics could be extended to *open systems*, i.e. those in which energy and reactive particles may enter or leave the system. Gibbs did this by adding *chemical work* terms to the combined law of thermodynamics. These chemical work terms are of the form $\mu_i \, dn_i$, where μ_i is the *chemical potential* of species i and n_i is the number of species i transferred into or out of system.[91]

The chemical potential of a thermodynamic system is the amount by which the energy of the system would change if an additional particle was introduced, with the entropy and volume held fixed. If a system contains more than one species of particle, there is a separate chemical potential associated with each species, defined as the change in energy when the number of particles of that species is increased by one.[89] The hypothesis put forward here is that *human potential* is inherently a *chemical potential*. Many agree with this hypothesis. Thermoeconomist Jing Chen, for instance, points out that work in our world is driven by differentials in chemical potential.[92]

Referring again to Kirkaldy, the significant contribution he made was to connect the concept of the potential of a system, in terms of a discussion of stability-seeking paths, to the measure of the Gibbs free energy. When particles, e.g. humans, enter or

leave the system, expression [4.11] must be modified to account for changes in the internal energy of the system. To do this, we introduce the concept of chemical potential μ, which can be defined as the energy increment of the system when a single chemical species is added at constant entropy and fixed internal parameters.[90] In this manner, the chemical potential measures the tendency of particles to diffuse. This characterization focuses on the chemical potential as a function of spatial location. Chemical species, to repeat, tend to diffuse from regions of high chemical potential to those of low chemical potential.[93]

According to mental creativity theorists, the mental state which precedes a creative act is best described as one of uncertainty and confusion.[94] From Kirkaldy's perspective, this picture is quite consistent with the view that these types of unsure mental states are unstable minimums of thermodynamic kinetic functions, namely the Gibbs free energy function. Furthermore, we are told, resistance to change of certain mental states to external perturbations supports the view that such neurological flow configurations represent exceptionally stable steady-states, correlative to the thermodynamic criterion, given by [4.10], for stable equilibrium configurations in isothermal, isobaric systems.

As such, we can also write [4.10], namely $\delta(G) = 0$, as a differential with respect to time dt. The operator used here, little delta δ, according to Gibbs, again, is the 'variation produced by any variations in the state of the parts of the body.' If the body is a working body consisting of chemical species and if [4.10] is satisfied, this means that if we vary the thermodynamic state of the working body, in any way, there will be no change in the free energy of that body during that time interval, meaning that no usable work will be produced. This can be written as such:[95]

$$\frac{dG}{dt} = 0 \qquad [4.20]$$

In 1977, Russian physical chemist Georgi Gladyshev, one of the key founders of the science of human thermodynamics, began to use criterion [4.20] to model the process of evolution on the technique and theory of chromatography In chemistry, *chromatography* is a versatile way of separating the components of a chemical mixture based on the unique attraction tendencies of each species to the conditions of the substrate.[96]

There are many types of chromatography, but all involve a mixture of chemical species carried in the 'mobile phase', moving across or through another chemical structure called the 'stationary phase'. This is analogous to how biological species move, migrate, and are carried within the body of the biosphere (mobile phase) as they seasonally attach to different bonding sites, i.e. territories (stationary phase).

In chromatography, the components, i.e. chemical species, of the mixture move at different rates, depending on the ease at with which they mix with and are

attracted to the stationary phase and the mobile phase.[97] This causes the mixture of chemical species to separate into bands of relatively pure components as they move through the chromatography system. Here, then, mixtures of chemical species, analogs to biological species, separate into groups and attach to different bonding sites based on the characteristic stabilities of each species. This model, subsequently, represents a correlative method by which biological species move though and hence evolve in each of many differing biospheric system hierarchies as they bind selectively into different ecological niches and hence separate into bands of relatively pure species.[98]

In 1995, medical biologist and complexity theorist Stuart Kauffman, in his book *At Home in the Universe*, asks 'from where did all the bubbling activity and complexity of life arise?' To this query, he states 'ultimately, it must be a natural expression of a universe that is not in equilibrium, where instead of the featureless homogeneity of a vessel of gas molecules, there are differences, potentials, which drive the formation of complexity.' He further goes on to declare 'it is a universe of stunningly abundant free energy *G* available for performing work. The life around us must somehow be the natural consequence of the coupling of that free energy *G* to forms of matter.' Interestingly, Kauffman defines *life* as an autonomous agent, i.e. a system situated in and part of an environment to which it senses, capable of reproducing itself, and of completing at least one thermodynamic work cycle.[99] A *thermodynamic cycle*, e.g. the Carnot cycle, as discussed, is a series of thermodynamic processes or transformations which returns a system to its initial state. In human life, to reiterate, an example would be the typical workweek. With the return of every Monday, a person's system is returned to its initial state; although this process is not a reversible one. This means that a certain amount of non-functionable transformation-energy, such as interpersonal conflict or non-optimized work energy, is irretrievably lost each week, by virtue of the fact that it cannot be converted into work.

In 2003, theoretical chemist and Nobelist John Avery, in his excellent book *Information Theory and Evolution*, tells us that the phenomenon of life, including its origin and evolution, as well as cultural evolution, actuates against the background of thermodynamics, statistical mechanics, and information theory. In this book, we are presented with the argument that 'the seeming contraction between the second law of thermodynamics, i.e. that isolated system tend towards disorder, and the high degree of order and complexity produced by living systems, has its resolution in the information content of the Gibbs free energy *G* that enters the biosphere from outside sources.' Gibbs free energy, according to Avery, is the thermal answer to the entropic paradox of evolution. In sum, free energy is the defining factor in life, not entropy.

Entropy and beauty

In the history of science, over the last century, entropy has come to be associated with beauty. In general, the more atomically ordered a molecular system or structure is, the lower is its entropy. Perfect crystals or perfectly ordered atomic systems will have entropy values close to zero. Diamond (carbon), the eight-carat Harry Winston diamond wedding ring (very beautiful) being one example, for instance, has an entropy value of 2.4 (J/K·mol), whereas graphite (carbon), pencil lead (less beautiful) being one example, has an entropy value of 5.69 (J/K·mol). Disordered systems tend to have high values of entropy. Along these lines, just as people desire a perfectly ordered life, which equates to perfectly ordered human molecular systems, then so to might people also desire those objects or systems indicative of low entropy, thus correlating beauty with entropy.

In 1928, astronomer Sir Arthur Eddington, in his noted book *The Nature of the Physical World*, stated that if he were forced to arrange the quantities of: distance, mass, electric force, entropy, beauty, and melody, into two categories, that he would put entropy alongside beauty and melody and not with the first three. He would do this because, as he states: 'entropy is only found when the parts are viewed in association, and it is by viewing or hearing the parts in association that beauty and melody are discerned. All three are features of arrangement.'[100]

Similarly, in 1964 when NASA began to make plans to look for life on earth, British scientist James Lovelock was asked to develop a life detection system to be used on a voyager sent to Mars. Based on the logic of Schrödinger's 1944 book *What is Life?,* Lovelock postulated the argument that to look for and hence recognized life one would 'look for structures characterized by entropy reduction (↓S), since this must be a general characteristic of all forms of life.'[101] Several years later, in 1979, after think about the relation between entropy, fitness, beauty, and survival, Lovelock stated 'I wonder if a positive answer would enable us to rate beauty objectively, rather than through the eye of the beholder. We have seen that the capacity greatly to reduce entropy ↓S or, to put it in the terms of information theory, greatly to reduce the uncertainty of the answers to the questions about life, is itself a measure of life. Let us set beauty as equal to such a measure of life. Then it could follow that beauty also is associated with lowered entropy, reduced uncertainty, and less vagueness.'[102]

In 1988, British theoretical physicist Stephen Hawking, in his *Illustrated A Brief History of Time*, put forward the argument that: knowledge retention is correlated to increased neurological organization and hence to lowered levels of neurological entropy.[103] As knowledge retention correlates to occupational viability, and as occupational viability correlates to sexual attractiveness, it can be argued that Hawking was the first to make a direct connection to low neurological entropy levels ↓S and heightened sexual attractiveness.

In 2005, similarly, thermoeconomist Jing Chen, in his *The Physical Foundations of Economics – an Analytical Thermodynamic Theory,* tells us 'people generally agree that life processes are thermodynamic processes and that the lower needs of human beings, such as eating, are thermodynamic processes. But the higher needs, such as literature, arts, are seen as beyond the working of the entropy law.' Good poems, literary masterpieces, and distinct paintings, etc., according to Chen, are rare events, characterized by high information content, which represents low entropy levels ↓S.

Based on these arguments, Chen boldly declares 'the developments in cognitive sciences reveal that the higher needs of human beings are methods of attracting members of the opposite sex in the competition for reproduction, or sexual selection. Organisms have evolved the ability to reproduce sexually for about one billion years. Since the entropy law, which states that closed systems tend towards states of higher entropy ↑S, is the most universal law of the nature, it is natural that the display of low entropy levels evolves as the universal signal of attractiveness in sexual and social communication. From poem writing to money making, the pursuit of low entropy is the main drive of human behavior.'[104] Here, we note that Chen is missing the 'enthalpic drive', the other main drive of human behavior. The distinction between the two drives was first noted by chemists Gilbert Lewis and Merle Randall in their 1923 book *Thermodynamics and the Free Energy of Chemical Substances*.

The relationship between entropy and beauty, to note, is a more advanced topic in human thermodynamics. In particular, the measure of a person's neurological entropy is inversely proportional to the level or measure of a person's perceived neurological attractiveness; traits such as a sense of humor, occupational acumen, integrity, knowledge, etc. These traits can be mapped into a function of free energy.

Evolution and the combined law of thermodynamics

From these examples, it should be clear that evolution is a thermodynamic process. From a chemical thermodynamic perspective, the essence of evolution, then, is the sum of the reconfigurational movement patterns (growth) associated with the lifting, rearranging, and moving of the weight of atoms and molecules, as discerned through the lens of thermodynamic parameters, i.e. Gibbs free energy G, enthalpy H, entropy S, chemical potential μ, work W, temperature T, pressure, and volume V, etc., which quantify these dynamics. All biospheric dynamics can be reduced to the total set of processes in which earth-bound atoms and molecules are forced to move or evolve.

This lifting, rearrangement, or movement is what is called 'growth'. As such, within the earth system, there exists an interactive 92-element collection of atoms, molecules, and chemical species partitioned off into dynamically evolving subsystems, linked together through the thermodynamic mechanism of exergonic-endergonic coupling. In addition, from a second perspective, we can view the links

of each coupling in terms of matter-energy exchanges, e.g. sustenance, information, tactile, or financial exchange, etc. Combined, these processes actuate, in mechanism, according to the thermal driving force of photon exchange.

There are, however, restrictions to this evolutionary process. It is a certainty that *the variation in energy of a system during any transformation is equal to the amount of energy that the system receives from its environment.* This, again, is the ***first law of thermodynamics***. Similarly, *the algebraic sum of all the transformations occurring in a cyclical process can only be positive, or, in the extreme case, equal to nothing*. This is the ***second law of thermodynamics***. The stipulations implied by the first and second laws combined mathematically, through [3.2], [3.5], and [4.5], to yield the following fundamental governing equation:

$$dU - T\,dS + PdV \leq 0 \qquad [4.21]$$

This mathematical inequality, known as the ***combined law of thermodynamics***, involves the zeroth law through the concept of temperature T, the first law through the internal energy U, and the second law through the entropy S, and the third law though the calculations of thermodynamic free energy G and chemical affinity A near absolute zero.[105] The inequality sign indicates that the process is irreversible. This encompassing version of the combined law can be simplified with a few substitutions. First, we rearrange [4.21] to arrive at:

$$dU + PdV - TdS \leq 0 \qquad [4.22]$$

We then let: $H = U + PV$, as mentioned, and define this quantity to be a type of energy called 'heat energy' symbolized by H; with substitution into [4.22] this gives:

$$dH - TdS \leq 0 \qquad [4.23]$$

We then let: $G = H - TS$, as mentioned, and define this quantity to be a type of energy called 'free energy' symbolized by G; furthermore, we define the quantity TS to be a third type of energy and call it 'transformation energy'. With substitution into [4.23] this gives:

$$dG \leq 0 \qquad [4.24]$$

Next, we replace the instantaneous differential dG with the more functionable ΔG, which means that free energy changes can be calculated over longer reaction periods. Mathematically, the quantity ΔG is the difference between the measures of the free energy of the final state of the system under study G_f with that of the measure of the free energy of the initial state of the system under study G_i or equalitively:

$$\Delta G = G_f - G_i \qquad [4.25]$$

This expression can also be written in terms of the instantaneous enthalpy H and entropy S measures of each species at the final and initial stages of a reaction as:

$$\Delta G = (H_f - H_i) - T(S_f - S_i) \qquad [4.26]$$

In human terms, as an example, if we hypothetically throw a couple of hundred-thousand humans into a melting pot, e.g. a newfound-land, and let them react, i.e. energetically evolve within 'reaction windows' in which migratory effects can be neglected in proportion to the size of the population, initially the system will have a quantifiable high measure of free energy $G_{Initial}$, i.e. it will possess a great deal of stored chemical potential energy by virtue of the workable bonds yet to be realized; yet, given time, the system will naturally evolve towards stability until the majority of stored energy is spent. Hence, the final state of the system will be characterized quantitatively by a lower measure of free energy G_{final}. The difference between these two values, again, is the change in Gibbs free energy ΔG, as shown in [4.25].

With these simplifications, i.e. [4.22] through [4.25], we have the following 'condensed' version of the *combined law of thermodynamics* for processes at constant temperature and pressure:

$$\Delta G \leq 0 \qquad [4.27]$$

In a general manner, according to geo-thermodynamicists Raymond Kern and Alain Weisbrod, the combined law of thermodynamics tells us that: *when a system evolves naturally, i.e. undergoes a natural process, in an isothermal manner, at constant volume or pressure, its Gibbs free energy G or Helmholtz free energy F always decreases.* They define this as the conditional statement for all types of evolution in isothermal earth-bound systems in which thermo-mechanical and thermo-chemical changes take place at constant volume or constant pressure:[106]

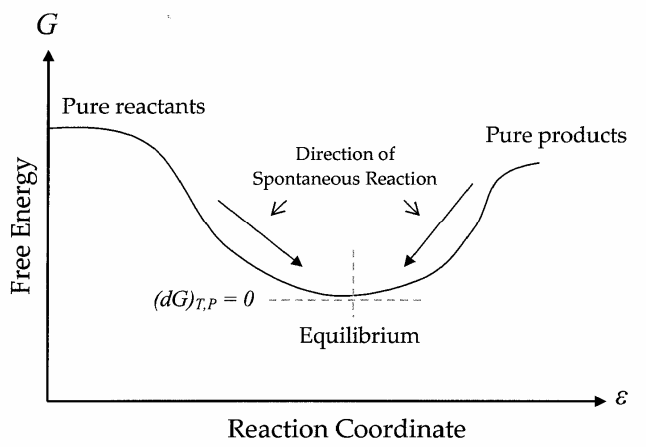
T, P constant, $\Delta G < 0$; T, V constant, $\Delta F < 0$
"Criterion of Evolution"

Here, to review, $F = U - TS$ is a type of chemical work energy, analogous to Gibbs free energy, which is used in isothermal, isometric systems, called the Helmholtz free energy. The Helmholtz free energy is named after the German physicist and physician Hermann von Helmholtz who in 1882, as mentioned, showed mathematically that chemical affinity is not given by the heat evolved in a chemical reaction but rather by the maximum work, or free energy, produced

when reactions were carried out reversibly. In other words, Helmholtz effectively replaced the outdated Newtonian concept of 'affinities' with the more correct Gibbsian concept of 'free energies'. Helmholtz free energy is similar to the Gibbs free energy, the difference being that it applies to systems in which temperature and volume are held constant, such as in artificial laboratory settings, e.g. electrochemical cells or in explosives research where pressure changes are great, etc.

In the earth reactor system, i.e. partitioned reactor subsystems at standard temperature and pressure, the latter evolution criterion applies: $\Delta G < 0$. For specialized purposes, such as in unique laboratory reaction conditions, where the temperature and volume are held constant, former evolution criterion applies: $\Delta F < 0$. Hence, throughout evolution, the earth, its reactor contents, and its connected processes have ascribed to the following criterion: $\Delta G < 0$ as the governing rule in the development of life and has been referred to by many as 'the physical essence of the evolution tendency'.[107] Stated another way, given a constant temperature, constant pressure, thermally driven, chemically reactive system, the direction of any spontaneous change is toward a lower free energy.[108]

As the following graphic shows, during a reaction the amount of free energy G decreases until the reaction is at equilibrium. If the reaction goes towards completion, the free energy minimum occurs very close to the pure products part of the curve:



The *pure reactants* could be, for example, a completely unattached, un-related, pair of random humans, $A + B$, and the *pure products* might be, for example, a fully-reacted, fully-bonded pair AB, with their complete or total amount of potential spent. The *reaction coordinate* ε is a variable that characterizes the 'extent' or degree to which a reaction has taken place. The reaction coordinate, in addition, goes by

various names such as degree of advancement, degree of reaction, extent of reaction, or progress variable, etc., and is essentially a measure of time.

From a chemical engineering perspective, if a mixture of chemical species is not in chemical equilibrium, any reaction that occurs at constant *T* and *P* must lead to a decrease in the total Gibbs free energy of the system.[109] In human chemistry terms, when a mixture of chemically reactive species, as a collection of human species, are thrown together into a reactive system, for example a high school, over the course of one school year, the human chemical bonds that break or form will do so in such a way as to lower the energy of the system; the components of the system, subsequently, become more stable through the formation of new bonds as energy is release in the form of work, and this correlates to a decrease in the total Gibbs free energy ↓G of the system. Everything in nature wants to be more stable.[110] The drive towards stability coupled with repulsion of instability are the two most powerful urges known to all of molecular-kind.

This inherent tendency towards free energy minimization in the process of the evolution of chemical species is strengthened by the near uniform acceptance of this principle in the learned scientific community. In 1997, for example, Swedish physical chemist Sture Nordholm, in his superb *Journal of Chemical Education* article 'In Defense of Thermodynamics: An Animate Analogy', declares: 'we are told that in nature, where we consider a small subsystem of fixed volume exchanging energy with its surroundings acting as a thermal reservoir,' that the corollary of the second law states:[111]

> Nature Seeks to Minimize the Free Energy *G* of a Subsystem.

This exact statement characterizes the energetics of Darwinian evolution, as well as atomic, chemical, biological, and social evolution. In short, evolution abides by the laws of thermodynamics, as do all processes in the universe.

Sociological thermodynamics

In 1997, building on the success of his 1978 article, Russian physical chemist Georgi Gladyshev published the phenomenal book: *Thermodynamic Theory of the Evolution of Living Beings*. In this book, the first of its kind to put forward a cogent and functional Gibbs free energy model of evolution, we find 'the value of ΔG corresponding to the formation of some society, which is a complicated thermodynamic system, can be estimated by calculating the work that is to be produced in order to build the structure of society.' Gladyshev calls these evolution energy dynamics a form of *sociological thermodynamics*. In short, according to Gladyshev, as the structure of a society is being built, the Gibbs free energy of that system is being minimized ↓G, per relaxation window.

This same social dynamic logic was elaborated on, similarly, by German physicist Ingo Müller in his 2002 article 'Socio-thermodynamics: integration and segregation in population', in which he included a discussion of *entropy of mixing*, i.e. the change in entropy when different species are mixed, and what he calls the *first and second law of socio-thermodynamics*, with discussions on working and heating aspects of human life. This latter detail about laws, to note, is an incorrect point of view. The laws of thermodynamics are one and the same for all atomic structures, regardless of molecular size or complexity level.

In any event, in his 2005 book *Entropy and Energy: A Universal Competition*, Müller devotes an entire chapter to the subject of socio-thermodynamics. In this chapter, Müller goes through an example of a metaphorical system of hawks and doves competing for the same limited resource. He compares the segregation and mixing of the two populations to that of physico-chemical systems separations defined by phase diagrams. Through his analogies, he correctly correlates pressure-volume boundary work to that of the 'part of the habitat lost' and states that 'such analogies emphasize the point of view that physical or sociological systems of many individual elements have common properties, whether they elements are atoms and molecules or birds and (maybe) men.'

One funny point, about the modeling of human social life through the difficult science of thermodynamics, as Müller states in his 2007 book *A History of Thermodynamics: the Doctrine of Energy and Entropy*, is that 'it is interesting to note that socio-thermodynamics is only accessible to chemical engineers and metallurgists. These are the only people who know phase diagrams and their usefulness. It cannot be expected, in our society, that sociologists will appreciate the potential of these ideas.' Here we concur, in that socio-thermodynamics is obvious to the chemical engineer, but the explanation of this obviousness to others is not so easy.

In 2004, Crotian mechanical engineer Josip Stepanic, in his article 'Social Equivalent of Free Energy', similarly, argues that social free energy is equivalent to physical free energy. He states that social free energy is 'a measure of social action obtainable in a given social system without changes in its structure' and argues that its construction 'is a consequence of response of a social system to recognized parts of environmental dynamics'.

In sum, the chemical, biological, and social evolution of molecular systems, human or otherwise, are each quantified by the combined law of thermodynamics, which states that dynamic, isothermal, isobaric reactive system will, on average, tend to evolve, out of quasi-stable false equilibrium configurations, towards free energy minimums, i.e. true equilibrium points, as dictated by natural quantum electrodynamic stability tendencies.

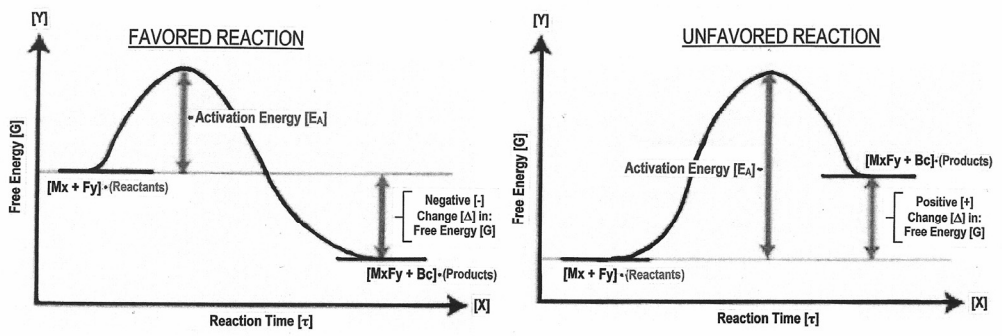
Love and the combined law of thermodynamics

With respect to human romantic chemical reactions in relation to the combined law of thermodynamics, in 2001, making the first-ever connection between human chemical reactions, Gibbs free energy, and human love, we find American computational chemist David Hwang, in his article: 'The Thermodynamics of Love', postulating a theoretical male *M* female *F* chemical reaction, in which free energy graphical calculations will determine if two people will be energetically perfect a pair or better separate.[112] Hwang states that commonly two people who fall in love with one another are often described as having a certain personal chemistry. Hwang goes on to state that 'although most people would be quite content to accept this convention at face value, the truth is that the correlation between romance and everyone's favorite branch of the natural sciences runs quite deep.' According to Hwang, 'while the terminology of thermodynamics explains the spontaneity of chemical reactions very well, it also applies directly to determining the success of human relationships.'

Hwang goes on to postulate a theoretical chemical reaction where as he states: two elements, 'male' *M* and 'female' *F*, combine to form a new compound called 'couple' *M-F*, as shown by the following reaction expression:

$$M + F \rightarrow M\text{-}F \qquad [4.28]$$

Here, Hwang uses a single dash '–' to represent the chemical bond. He then reminds us that to predict the likeliness that any given chemical reaction will proceed in the forward direction, chemists draw simple curves outlining the energy considerations:



In these diagrams, drawn originally by Hwang, the y-axis represents free energy *G* and the x-axis represents the progression of the reaction with time, i.e. the reaction coordinate ε. According to Hwang, individual human elements, *M* and *F*, with a collective high free energy *G* value are relatively reactive, such as a 'hot' single person, while a compound, *M-F*, with a low value of *G* is likely to be stable, such as a 'warm' married couple. Thus, a reaction in which *G* decreases will favor the

formation of the product *M-F* because the state of the products have less free energy than the starting compounds and are more stable.[113] These suppositions, as we see, are ground-breaking!

To encapsulate the essential free energy minimization principle of chemical thermodynamics, Hwang states the following rule concerning reactions:

> If the given male-female reaction has a very negative free energy, then it is expected that the system will spend most of its time together as a strong couple.

The graphics shown above, as noted, are modified a bit from Hwang's original. Instead, here we use the standard notation for human chemical reactions, in which *Mx* symbolizes a male, *Fy* symbolizes a female, *MxFy* symbolizes a male and female bonded into a relationship, and *Bc* symbolizes a baby-child.[114] Furthermore, instead of the simple couple forming reaction [4.28] we show the energetics associated with the more dominate child reproduction reaction, in which a man bonds with a woman, they react together, exchange genetic material, and produce a child:

$$Mx + Fy \rightarrow MxFy + Bc \qquad [4.29]$$

Normal small scale chemical reaction rates are in units of moles per cubic decimeters per second, $mol \bullet dm^{-3} \bullet s^{-1}$. The current human chemical *reaction rate*, i.e. how fast a reaction takes place, for [4.29] is 4.59 human molecules per second per 10^{21} cubic meters. In other words, every 24-hours, on average, 500,000 children are born, i.e. synthesized, in the volume of the earth (reactor).[115] The reaction rate for [4.29], however, varies per latitude (temperature distribution) as well as per decade. Those closer to the equator, for example, where ambient temperatures are higher, tend to react faster, more often, and produce more product.[116] Statistically, 85% of people will transform through this human chemical reaction.[117]

Technically, reaction [4.29], in mechanistic terminology, is what is called a *double displacement reaction*, of the form shown below:

$$AB + CD \rightarrow AD + BC \qquad [4.29]$$

In human chemical terms, a man *Mx* parts with the genetic component of his sperm *Sp*; a woman *Fy* parts with the genetic component of her egg *Eg*; and they both emerge newly 'transformed' after the birth of their child, in the form of a new molecular structure, i.e. parents bonded into a working chemical relationship *MxFy* with an attached embryo *SpEg* uniting them:

$$MxSp + FyEg \rightarrow MxFy{\equiv}SpEg \qquad [4.31]$$

Soon thereafter, still being attached significantly to the parental structure *MxFy*, the sperm-egg molecular entity *SpEg*, in the shape of what is called a *morula*, i.e. a globular solid mass of blastomeres formed by cleavage of a zygote, will begin to transform or grow into the structure of a young child *Bc*. Given time, the child will eventually begin to detach, in a predominate manner, from the parental structure:

$$MxFy \text{ --- } Bc \rightarrow MxFy + Bc \qquad [4.32]$$

In this manner, the newly created human molecule *Bc* will go off into the world as a newly formed individual.

As we see, these human chemical reactions are quite intuitive and very easy to depict. Do note, however, although simplistic-looking, these human chemical reactions actually embody principles and theories far greater in complexity and extent than can be detailed in this short book. It must be understood that the second-by-second mechanism underlying expressions [4.28] through [4.32], invariably, needs to be explained in terms of only two components: electrons and photons. To do this is quite a tedious process and many new perspectives on life must be digested. We will only outline this objective herein.

In this direction, using the triple dash '≡' to represent the basic marriage bond, a central question we must ask is *how do we chemically explain the structure, mechanism, and dynamics of the following bonded entity?*

$$Mx{\equiv}Fy \qquad [4.33]$$

To find a solution to this intricate problem, we will employ the famous *Feynman Problem Solving Algorithm*, which is a basic problem solving technique used by the American physicist Richard Feynman, as facetiously observed by his colleague Murray Gell-Mann in the NY Times:

Feynman Problem Solving Algorithm

1. Write down the problem
2. Think very hard
3. Write down the answer

One first has to realize, however, that there is an actual problem before using this algorithm. In other words, superficially, molecular structure [4.33] seems to be a straightforward issue, it is a man and a woman bonded in a relationship; yet, in chemical terms, there is more to this picture than meets the eye. To simplify our

thermodynamic calculations, rather incorrectly, we may actual ignore structure [4.33] and assume that the basic human chemical reaction is the process in which a male *M(slv)* species reacts with a female *F(slv)* species to produce a baby *B(slv)* species, where label 'slv' signifies that we are speaking, approximately, of chemical species in the solid-liquid-vapor, e.g. bone, blood, oxygen, state:

$$M(slv) + F(slv) \rightarrow B(slv) \qquad [4.34]$$

To come to understand the significance of structure [4.33] with respect to reaction [4.34] involves a significant amount of mental gymnastics and many new theoretical developments. From a human perspective, entity [4.33] is the single harmonious unit of a husband and a wife bonded in matrimony. From a chemical perspective, where the symbol '≡' signifies a human chemical bond, entity [4.33] is a single molecular structure, i.e. a man *Mx* and a woman *Fy* chemically bonded, *Mx*≡*Fy*, as one united relationship rather than two separate individuals. Using chemical terminology, this structure is what would be defined as a *di-humanide molecule*. Colloquially, this structure is called the married couple. When viewing this bonded structure from a distant observational point of view, supposing for example we were studying human chemical reactions from a far distant galaxy, the molecular perspective would be the correct one.

In the next chapter, we will build on this framework by introducing the concept of cosmic molecular evolution, i.e. the evolution of atoms and molecules in the big scheme of the universe over the last 13.7 billion years. Throughout this presentation, and in the chapters to follow, the central question to be answered will be what is the composition of the human chemical bond [≡], in terms of fundamental forces and fundamental particles, hypothetically holding structure [4.33] together? An entire new human chemical vocabulary will need to be assimilated if we are to understand this phenomenon.

5 – Molecular Evolution:

"The body contains only 2 percent of the atoms that were spinning in it one year ago."

George Harrison, *Science Writer*[1]

One of the most tenuous topics in science is that of evolution.[2] In surveys conducted in 2005, people in the U.S. and thirty-two European countries were asked whether to respond 'true', 'false' or 'not sure' to this statement: 'human beings, as we know them, developed from earlier species of animals.' The United States had the second-highest percentage of adults who said the statement was false and the second-lowest percentage who said the statement was true. Only adults in Turkey expressed more doubts on evolution. In Iceland, 85 percent agreed with the statement.[3] In sum, everyone wants to know how, why, and where human life fits in the grand scheme of time and the growth or evolution of the universe, but there is not yet uniform agreement as to how, why, and where this fit occurs.

The study of the process of evolution, from the big-bang to the present, is called *cosmic evolution* or 'universal evolution', the scientific study of universal change.[4] The central focus of cosmic evolution is to synthesize the many varied changes involved in the assembly and composition of radiation, matter, and life throughout the history of the universe.[5] The regulatory process of cosmic evolution, according to American astrophysicist Eric Chaisson, is governed 'largely by the laws of physics, particularly those of thermodynamics.'[6]

In short, about 13.7 billion years ago, the early universe exploded into existence through a yet unknown expansion process.[7] About 9.1 billion years later, the young earth began to form from an accretion disc of elemental matter revolving around a new sun. Over the next half a billion years, the surface of the earth cooled enough to allow crust to solidify. Soon thereafter, the atmosphere and the oceans formed. In time, life emerged. This evolution picture, however cogent it may be, is incomplete.

The errors in this terse outline are the misuse of the anthropomorphic term 'life' and the dependence on the idea of 'emergence'. Technically, the earth system, including the contents of the biosphere, is a 92-element, continuously-stirred, variably-spinning, thermally-warmed, chemical tank reactor (CSTR) that has been reacting and transforming, non-stop through a thermodynamically-directed, punctuated mechanism of planetary chemical evolution.[8] The central words in this chemical process are *coupled* and *continuous*. The reactions don't stop and they didn't start on a particular day; as the following evolution table shows:

Element Count	Molecular Evolution Table	Name	Date
N/A	*Fermions:* e^-, ν_e, u, d, μ^-, ν_μ, c, s, τ^-, ν_τ, t, b *Gauge bosons:* g_{ab}, γ, W^+, W^-, Z^0, G	Elementary Particles	13.7 BYA
1	H, He-3, He-4, Li	Atoms	3E5 YAB
1	H_2	Hydrogen	
2	H_2O	Water	2E8 YAB
3	CH_4O	Methanol	
4	CH_4ON_2	Urea	4.6 BYA
5	$C_{10}H_{16}O_{13}N_5P_3$	DNA	
6	$C_{21}H_{36}O_{16}N_7P_3S$	Coenzyme A	
7	$C_4H_3O_2NS_2NaI$	mol-7	4.4 BYA
8	$C_{20}H_{22}O_7N_2SNaIPt$	mol-8	
9			
10	$C_{E5}H_{E5}O_{E4}N_{E4}P_{E2}S_{E2}Ca_{E2}K_{E2}Cl_{E2}Na_{E2}$	Intermediate	4.2 BYA
11			
12	$C_{E7}H_{E7}O_{E6}N_{E6}P_{E4}S_{E4}Ca_{E4}K_{E3}Cl_{E3}Na_{E3}Mg_{E2}Fe_{E2}$	Pro-bacteria	4.0 BYA
13			
14			
15	$C_{E10}H_{E10}O_{E10}N_{E9}P_{E8}S_{E8}Ca_{E8}K_{E6}Cl_{E6}Na_{E6}Mg_{E6}Fe_{E5}$ $Si_{E4}Mn_{E2}Co_{E2}$	Prokaryote (Bacteria)	3.85 BYA
16			
17			
18	$C_{E16}H_{E16}O_{E16}N_{E15}P_{E14}S_{E14}Ca_{E14}K_{E12}Cl_{E12}Na_{E12}Mg_{E12}Fe_{E11}Fr_{E11}$ $Si_{E10}Cu_{E9}Mn_{E8}Se_{E8}Co_{E7}$	Pre-Aquatic Worm	2.6 BYA
19			
20			
21			
22	$C_{E22}H_{E22}O_{E22}N_{E21}P_{E20}S_{E19}Ca_{E20}K_{E18}Cl_{E18}Na_{E18}Mg_{E18}Fe_{E17}Fr_{E17}$ $Zn_{E16}Si_{E16}Cu_{E15}I_{E14}Mn_{E14}Se_{E14}Mo_{E13}Co_{E13}V_{E12}$	Fish	0.7 BYA
23		Reptile	350 MYA
24	$C_{E26}H_{E26}O_{E26}N_{E25}P_{E24}S_{E23}Ca_{E24}K_{E22}Cl_{E22}Na_{E22}Mg_{E22}Fe_{E21}Fr_{E21}$ $Zn_{E20}Si_{E20}Cu_{E19}Be_{19}I_{E18}Mn_{E18}Se_{E18}Cr_{E18}Mo_{E17}Co_{E17}V_{E16}$	Old World Monkey	30 MYA
25		*A. Afarensis*	5.0 MYA
26	$C_{E27}H_{E27}O_{E27}N_{E26}P_{E25}S_{E24}Ca_{E25}K_{E24}Cl_{E24}Na_{E24}Mg_{E24}Fe_{E23}Fr_{E23}$ $Zn_{E22}Si_{E22}Cu_{E21}Be_{21}I_{E20}Sn_{E20}Mn_{E20}Se_{E20}Cr_{E20}Ni_{E20}Mo_{E19}Co_{E19}V_{E18}$	Human (*H. Sapiens*)	0.2 MYA
27			
28		Evolution	

This molecular evolution table shows some of the basic building blocks (reactants) involved in evolution, from the hydrogen molecule H_2 to the human molecule *Mx* or *Fy*, over the last 13.7 billion years.[9] In short, human species evolved from hydrogen species and there is a seemless continuity in the evolution lineage.

> “In respect of man’s anatomical and physiological equipment a continuity in structure with that of other species is unquestionable. In respect of his behavioral equipment continuity of structure may be less evident, but were continuity to be totally absent all we know of man’s evolution would be contradicted.”
>
> – ***John Bowlby***, British Developmental Psychologist [1969]

The first row shows the basic matter particles, called *fermions*, and force particles, called *gauge bosons*, found at the initial high-temperature reaction phase of the exploding universe.[10] The second row shows the three types of atoms, hydrogen *H*, helium *He*, and lithium *Li,* that had energetically assembled during the first 300 seconds to 300,000 years after the bang (YAB).

The galaxies’ first stars, which formed only 200 million years after the bang, consisted almost entirely of hydrogen and helium. Through a process of nuclear fusion, in which *H* and *He* were fused, these stars slowly made the heavier elements: from carbon *C* to calcium *Ca*. In time, large stellar molecular clouds, heated by stars embedded within it, began to produce the galaxies’ first molecules, those such as: methane (CH_4), ammonia (NH_3), water (H_2O), hydrogen sulfide (H_2S), hydrogen cyanide (HCN), carbon monoxide (CO), carbon dioxide (CO_2), nitrous oxide (N_2O) and phosphate (PO_4^{3-}).

Shortly thereafter, these sets of small molecules reacted to produce many larger 3-element and 4-element molecules, such as: propylene (C_3H_6), β-carotene ($C_{40}H_{56}$), α-pinene ($C_{10}H_{16}$), vanillin ($C_8H_8O_3$), camphor ($C_{10}H_{16}O$), retinol ($C_{20}H_{30}O$), glucose ($C_6H_{12}O_6$), sucrose ($C_{12}H_{22}O_{11}$), oleic acid ($C_{18}H_{34}O_2$), dopamine ($C_8H_{11}O_2N$), cocaine ($C_{17}H_{21}O_4N$), glycine ($C_2H_5O_2N$), alanine ($C_3H_7O_2N$), and tyrosine ($C_9H_{11}O_3N$). Soon, bigger and more complex 5-element molecules were formed, such as the pigment chlorophyll ($C_{55}H_{72}MgN_4O_5$), RNA ($C_{10}H_{12}O_6N_5P$), and DNA ($C_{10}H_{16}O_{13}N_5P_3$), which in turn evolved into 6-element molecules, such as coenzyme A ($C_{21}H_{36}O_{16}N_7P_3S$); these evolved into larger more complex 7-element molecules, and so on. Eventually, large 26-element molecules called humans were formed about a medium-sized star called the sun, a reactionary event that began to occur about 200,000 years ago.

In short, life is reactionary process of molecular evolution governed by the four laws of thermodynamics.[11] In addition, if we define life to be any type of animate molecule, then the essential point at which we might say ‘earth life’ technically began, would be the exact second the sun ignited. Even before this, however, atoms and molecules would have been reacting, evolving, and transforming in the pre-sun aggregate of gaseous matter. The sun’s current age, determined using algorithmic computer models of stellar evolution and nucleo-cosmochronology, is thought to be about 4.57 billion years.[12] In this manner, molecular evolution, within the

delineating Kármán line region, which is the 62 mile-high space-earth boundary demarcation, above the earth's surface, can be written in simple chemical shorthand as such:

$$\bullet\bullet\bullet D \rightarrow E \rightarrow M_1 \rightarrow M_2 \rightarrow M_3 \rightarrow M_4 \rightarrow M_5 \rightarrow M_7 \rightarrow M_8 \rightarrow M_9 \bullet\bullet\bullet$$

Here, D is the accretion disc of elements, E is the solidified earth, M_1 is a distinct species of molecular structure, found within the Kármán line boundary, M_2 is a distinct species evolved from M_1, M_3 is a species evolved from M_2, and so on, and in which each arrow represents a specific, energetically-defined, chemical reaction or series of coupled chemical reaction mechanisms. In other words, to go through one example of an *evolution lineage*, about 4.3 billion years ago an 8-element molecule M_N, which itself had formed from a previous species of 7-element molecules M_{N-1}, reacted with other molecules of its own kind, via chemical mate recognition systems, to eventually form a new species of 9-element molecules M_{N+1}.[13] In time, these species of 9-element molecules would have reacted in a continuous manner to atomically-evolve into species of 10-element molecules and then eventually into a 12-element pro-bacterial species, which we might call M_1, a social collective that existed 4.0 billion years ago. Soon thereafter, these pro-bacterial species would have reacted further with similar species of their own kind to eventually form species M_2 and then eventually a prokaryote species M_{2+X}, such as bacteria, where X would be a whole number related to the number of intermediate species reaction steps involved in the evolution.

These M_{2+X} molecular species would eventually react to form species of aquatic worms M_{3+X}, who in turn gave way to various evolved species of fishes M_{4+X}, which soon gave way to land-walking species of fishes M_{5+X}, that eventually transformed into species of reptiles M_{6+X}, which gave way, about 245 to 66 million years ago, to mammals M_{7+X}. These species of mammals soon evolved into small dexterous tree shrews M_{8+X}, which gave way to old world monkeys, M_{9+X}, a chemical transition that occurred 30 million years ago. In time, collective social systems of these reactive old world monkeys transformed into systems of chimpanzee species about 7 million years ago. About 5.5 million years ago, mating systems of chimpanzee species eventually reacted to form evolved species of hominids. The hominid line, of which *Homo sapiens*, the anatomically modern species of humankind, is the culmination, separated from the ape social system between 4 and 5 million years ago, at which point the two distinct species had developed separate mate recognition systems.[14]

The first hominid to be considered human, *Homo habilis*, appeared about 2.4 million years ago. About 1.9 million years ago *Homo habilis* was replaced by *Homo erectus*, with a brain size about two-thirds that of modern humans. Over the next million years this proportion grew to three-quarters, the brain evolving rapidly as the climate fluctuated from dry glacial periods to warmer, moister inter-glacial periods.[14]

Homo erectus was the first hominid to live outside of Africa. As early as 1.8 million years ago the *Homo erectus* population had spread through tropical south and southeast Asia and colonized temperate areas of Europe and northern China. In this period, the isolated *Homo erectus* populations began to evolve in different ways, especially after the 500,000 years ago mark. In Africa, archaic humans evolved into anatomically modern humans, *Homo sapiens*, who began to appear about 135,000 years ago in the East African Rift valley.[14]

All modern day human beings are direct descendents of these Rift valley Homo sapiens. In particular, according to genetic evidence, namely lineage tracking of the Y-chromosome, a marker that only transfers down the male line, it is known that every single person alive to day is a direct descendent of a single man who lived in Africa 60,000 years ago. In time, the African population, descendent from this man, began to split. Estimates indicate that the African / East Asian split occurred 41,000 years ago, the African / European split occurred 33,000 years ago, and divergence between the Europeans / East Asians occurred 21,000 years ago.[15] By the end of the Ice age, about 10,000 years ago, only some oceanic islands, Antarctica, and some parts of the high Arctic remained completely uninhabited by humans.[14]

This overall evolution reaction description, of course, is a huge simplification for what is invariably a more immense chemical reaction mechanism, involving billions of various intricate evolution reactions. In more technical detail, numerous variations of large-scale, hydrogen-molecule to animal-sized, molecular reactions would have been directly involved, those such as isomerization, combination, decomposition, single displacement, and double displacement reactions, etc., many of which would have been energetically coupled.

The generic, albeit incorrect, current theory of the origin of life, however, holds that once upon a time, three or four billion years ago, lightning struck a puddle of water containing a kind of warm chemical chicken broth and triggered the formation of amino acids, the building blocks of life.[16] This interesting warm pond picture originated from a 1871 letter written by English naturalist Charles Darwin to English botanist Joseph Hooker wherein Darwin made the suggestion that the original spark of life may have begun in a 'warm little pond, with all sorts of ammonia and phosphoric salts, lights, heat, electricity, etc. present, so that a protein compound was chemically formed ready to undergo still more complex changes.'

In 1936, improving on Darwin's warm pond model, Russian biochemist Aleksandr Oparin demonstrated that the formation of living tissue was preceded by a long and gradual chemical evolution involving nitrogen, oxygen, and other compounds. The evolution process, according to Oparin, would have passed through three distinct chemical phases: from inorganic, to organic, to biological chemistry. Oparin's model is a step up from Darwin's; however, dividing chemistry into phases is not the most intuitive way visualize things. In other words, chemistry is chemistry. Human chemistry is no different then biological chemistry, organic

chemistry, or inorganic chemistry, it's all the science of reactions between molecules.

In his *The Origin of Life*, Oparin argued that a 'primeval soup' of organic molecules could be created, from a system of inorganic molecules, in an oxygenless atmosphere through the action of sunlight. These would combine in ever-more complex fashion until they dissolved into what he called a coacervate droplet. These droplets would grow by fusion with other droplets, and reproduce through fission into daughter droplets, and so have a primitive metabolism in which those factors which promote cell integrity survive, whereas those that don't became extinct.

Curiously, not much on this picture has changed up to the present. In September of 2000, for example, a 'What is Life?' conference was held in Modena, Italy, which was attended by about a hundred scientists, philosophers, and theologians. Between the scientists, a debate erupted in regards to what the first form of life was. One expert on lipid molecules argued that life began with the formation of the first semipermeable lipid membrane, a structure that encases cells. A noted metabolism researcher argued that life began with the first metabolic cycle, thus giving cells the power to convert energy and atoms into useful molecules. The molecular biologists were adamant that that the first living entity must have been an RNA-like genetic system that carried and duplicated biological information. One mineralogist even threw out the wild card that the first life was a self-replicating mineral.[17]

These elementary descriptions, however pleasing to the mind they may be, are incongruent with modern standard molecular evolution tables.[9] To elaborate on this, presently, between the hard-sciences, namely chemistry, mathematics, and physics, and soft-sciences, namely biology, psychology, and sociology, there lies a chasm of incongruence so prevalent in acceptance that it seemingly passes unnoticed even under the most astute of observation.[18] On one hand, we preen ourselves on appeal of biology and find there to be a genetic 'struggle' for existence; on the other, we entrench ourselves in the exacting fortitude of chemistry and find there to be a graceful symphony of exacting chemical reactions. In other words, on the biological or psychological side of the fence, molecules are thought to be in a *struggle*, and on the chemical side of the fence, molecules *react*. Only one of these suppositions can be correct.

To suppose, for example, that the oxygen atom *O* struggles to exist as it interacts with hydrogen *H* to form water H_2O, is comparable to saying that when a raindrop, i.e. an aggregate of water molecules, falls from a saturated cloud to the barren earth that it is in a sense 'struggling' along its path. Both statements are near to absurd. The raindrop falls because it is gravitationally 'forced' to fall. The oxygen atom reacts because it is electromagnetically 'forced' to react. There is no struggle. All movements in the universe occur because they are forced to occur. There may, at times, however, exist a certain conflict, ambivalence, indecision, or resistance of forces, but these are always forces.

A second point to this evolution chasm lies within the 'origin of life' question. According to standard references, such as Britannica, the majority of the scientific hypotheses of the origin of life will fall into one of three categories: (a) *life* spontaneously and readily arises from nonliving matter in short periods of time, today as in the past, (b) *life* is coeternal with matter and has no beginning; life arrived on the earth at the time of the origin of the earth or shortly thereafter, or (c) *life* arose on the early earth by a series of progressive chemical reactions, which may have been likely or may have required one or more highly improbable chemical events.

As to the first option, the idea that life spontaneous generates is an outdated concept by many centuries. Egyptians, as early as 3000 BC, had noted the spontaneous appearance of beetles from moist camel dung mounds following three days of solar incubation and also correlated the spontaneous appearance of mice with the annual occurrence of the Nile flood, thus reasoning that mice were begotten from wet mud and beetles from moist dung. Similarly, Aristotle, in third century BC, noted that aphids spontaneously appear after dew falls on plants and that fleas derive from putrid matter. This type of antiquated logic continued onward for nearly two-thousand-years until exact scientific experimentation began to disprove each theory. The downfall of the various spontaneous generation theories, in finality, was Italian physician Francesco Redi's 1668 experiment where he showed that the spontaneous generation of maggots from rotten meat was due not to any type of hypothetical generation, but rather due to the simple process whereby flies lay eggs in the meat.

As to the latter generic origin of life options, certainly life arose by a series of progressive chemical reactions, this is obvious; but that life is coeternal with matter and has no beginning is a tricky issue.[19] The real answer, of course, is that the first molecule in the universe was the hydrogen ion molecule H_2^+ (a bonded system of two protons and one electron), energetically formed about thirteen billion years ago, from high-speed systems of quarks and electrons, after the early hot universe cooled enough to have allowed atoms to form, the rest is chemical reaction mechanism history.[20]

Compounding this picture, for many, however, is the perceived energy problem. That is, for an earth-bound biological molecule to form, an initial source of energy, different from that of standard sunlight, it is argued, would have been needed to ignite, spark, or start the imaginary 'original' chemical reaction. Hypothetical initial energy sources include: electricity from lightning activity, heat from deep sea thermal vents, gravitational energy from earth quakes, kinetic energy from meteor showers, warmth from volcanic activity, etc. Moreover, because fossil evidence indicates that bacteria existed some 3.85 billion years ago, most have argued that life began during these years when the right combination of chemicals came into contact with the right energy source. Interestingly, most of these theories seem to imply that the thermal energy from the sun has nothing to do with it? This is certainly wrong.

Another salient point of debate, which is silently incongruent, is that if humans are indeed molecules, and if humans are alive, then by logical extrapolation, either all molecules are alive or no molecules are alive or only certain types of molecules can be appropriately defined as being alive. This is an interesting puzzle. Life from a human chemical perspective is best defined as series or sets of evolving parallel biochemical reactions. The meaning of life, subsequently, is to react. On this definition, we might ask: what does it mean to react? Or, if something reacts, does that mean it is alive? These are fascinating questions with discernable answers.

The basic answer, is that it depends on a point of view. If one were a quark, for instance, then one would likely define other quarks to be alive. If one were a 36-element form of atomic-intelligence on a far distant planet, then one would *not* likely define human molecules to be alive, in an equivalent sense to themselves, similar to how humans view 16-element bacteria molecules. In human chemistry, we will define life to be a *measure of reactivity*. In other words, the rate of the reaction characterizes life. This type of classification again, however, comes down to a matter of point-of-view semantics. The advanced perspective, for example, would define all types of molecules, reacting or not, to be boson-driven atomic structures, the internal nature of which, would be classified a type of sub-atomic life (or sub-atomic dynamics).[21]

A fifth area of heated debate is the *selfish gene theory*, namely that some believe RNA was the first form of life, that RNA molecules reacted to form DNA molecules, and that DNA molecules, in which a strand of DNA is called a 'gene', are a type of selfish molecule, in which each gene, or segment of DNA, is only concerned with it's own welfare or advantage in life in disregard of other genes or molecules.[22] This phenomena clearly does not exist in chemistry, but is illogically believed to exist in biology. In other words, if an RNA molecule is, so-to-say, a 'selfish' molecule, then one also has to prove that every other molecule in the universe, such as a propylene C_3H_6 molecule, is selfish. This type of proof cannot be found. All molecules act and behave according to the laws of chemistry, namely quantum chemistry and chemical thermodynamics.[23]

The selfish gene theory, however, is popular and has interesting points about it. The theory itself, began with British evolutionary biologist William Hamilton's 1964 mathematical argument that the natural selection of 'selfish genes' can favor altruistic behavior among relatives.[24] Namely that, we each will help our extended family members, brothers, sisters, cousins, aunts, second cousins, etc., relative to the fractional proportions of genes we have in common with them.

In 1966, in relation to Hamilton's fractional gene theory, American evolutionary biologist George Williams, in his book *Adaptation and Natural Selection*, postulated that the gene itself is the basic unit of natural selection.[25] Specifically, Williams reasoned that 'the essence of the genetical theory of natural selection is a statistical bias in the relative rates of survival of alternatives, i.e. genes, individuals, etc. The

effectiveness of such bias in producing adaptation is contingent on the maintenance of certain quantitative relationships among the operative factors. One necessary condition is that the selected entity must have a high degree of permanence and a low rate of endogenous change, relative to the degree of bias, i.e. differences in selection coefficients.'[26] Williams argued that 'the natural selection of phenotypes cannot in itself produce cumulative change, because phenotypes are extremely temporary manifestations.' In other words, according to Williams, only the natural selection of genotypes can produce cumulative change.

The tipping point for the start of the various RNA-DNA evolution theories, was Austrian physicist Erwin Schrödinger's 1944 book *What is Life?* In this book, the very same book that famously postulated that 'life feeds on negative entropy', we are presented with the argument that every organism contains a 'hereditary substance' consisting of a few atoms. Moreover, the 'gene', according to Schrödinger, is a huge molecule, capable only of discontinuous change, which consists in a rearrangement of the atoms and leads to an isomerization. This atomic rearrangement, according to Schrödinger, will only affect 'a small region of the gene' and that 'a vast number of different rearrangements may be possible.' In addition, 'the energy thresholds, separating the actual configuration from any possible isomeric ones, have to be high enough, compared with the average heat energy of the atom, to make the change-over rate a rare event.' Schrödinger identifies these 'rare events' with spontaneous mutation.

In 1953, having been stimulated by Schrödinger's revolutionary ideas about this hereditary substance, biologists Francis Crick and James Watson discerned the double-helix, three-dimensional, atomic structure called deoxyribonucleic acid, i.e. DNA. This heredity molecule soon came to be known as the 'secret of life'.[28] In 1962, Crick and Watson were awarded the Nobel Prize for their 'discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material.'[28]

Since this discovery, then, DNA has been known as the main physical substrate to genetic information, and that it is capable of high fidelity replication through many generations. In this manner, a particular sequence of DNA, i.e. a gene, can have a high permanence and a low rate of endogenous change, and thus may function as unit of selection. The icing to the cake of this theory came in 1976, when British ethologist Richard Dawkins, in his book *The Selfish Gene*, proclaimed, in a manner similar to Descartes' *animal machine*, that humans are 'survival machines: robot vehicles blindly programmed to preserve the selfish molecules known as genes.' In short, the selfish gene theory, according to Dawkins, is essentially Darwin's theory of natural selection, but from a gene's-eye view of nature, in which all life forms are machines created by genes.[29] It is along these lines of reasoning that *The Selfish Gene* went on to become a million-copy international best-seller.

The selfish gene theory, however popular it may be, is far from perfect. Firstly, the basic weakness in this theory, aside from the off-idea that molecules are selfish, is that prior to the formation of RNA, the selfish gene theory falls apart. Current estimates indicate that bacteria, which contains RNA, may have existed about 3.85 billion years ago.[30] Hence, between the years 13.7 to 3.5 billion years ago there were no genes that we know of yet atomic and molecular evolution still took place.

Another point of inconsistency is that humans, for example, are comprised of 26 distinct elements. Hence, 21 of these elements, according to the selfish gene theory, are subservient to the elements carbon, hydrogen, nitrogen, oxygen, and phosphorus, the atoms of genes. In other words, are we to believe that 5 of the total 92 naturally occurring elements in the system of the earth control or create the behaviors of the rest? This is not the case, the bonding tendencies of carbon, i.e. tetra-valence, nitrogen, i.e. tri-valence, and oxygen, i.e. bi-valence, for example, do in themselves create and control the rest of the biosphere. In short, the selfish gene theory oversimplifies the relationship between genes, the organism, and the environment. The science of genetics, however, is certainly a fruitful line of research, but as far as evolution is concerned far too much importance is placed on segments of DNA as being the say-all of molecular evolution life. In short, the selfish gene theory is interesting and a close approximation, but the human dynamics and chemical life of molecules are more complicated than this.

Connected to this theory, is the idea that RNA was first form of life. The 'RNA world hypothesis', proposed originally by American micro-biologist Carl Woese in his 1968 book *The Genetic Code*, argues that RNA, i.e. ribonucleic acid, was the first life.[31] These little RNA molecules, it is argued, evolved into DNA and the protein world of today. The RNA molecule itself, however, is a complex, high-molecular-weight, 5-element macromolecule, arranged in the form of nucleotide chains with an approximate molecular formula of $(C_{10}H_{12}O_6N_5P)_Z$, where Z is the number of nucleotides in the chain. To form this complex macromolecular structure, this RNA molecule would have had to have evolved from a much older pre-RNA chemical species, and this pre-species itself would have had to have evolved from a more rudimentary, less complex species before that, and so on. As such, if we are to naively believe that the 5-element RNA was the first from of life, then we would also have to believe in the following backwards logic:

$C_4H_7O_4N$ (aspartic acid) – not alive
$C_{10}H_{12}O_6N_5P$ (ribonucleic acid) – alive
$C_{21}H_{36}O_{16}N_7P_3S$ (coenzyme A) – more alive

This type of reasoning, in which small 4-element molecules, such as aspartic acid, a crystalline amino acid found especially in plants, are not alive, whereas 5-element molecules, such as RNA, are alive, is clearly ridiculous. The hypothesis put forward

herein, to reconcile these areas of theoretical inconsistency, is that the human organism is 26-element molecule and that it as well as all other large-element molecules are dynamic atomic structures found within a 92-element, heat-fluxed, environment, which together react, form, and break bonds, evolve, and reproduce according to the four laws of thermodynamics. Moreover, there is no such reality as there being a specific energy-filled 'spark day' in earth's past in which molecules suddenly became lifelike, alive, or imbued with life, etc., as it is currently believed.

One example of how genes, biological structures, and thermodynamics relate to each other is the relationship between troop structure in Gorilla social systems and the neurotransmitter serotonin, the so-called 'confidence chemical'. If, for example, the alpha male of a troop dies or leaves, for whatever reason, this creates a stability gap in the social structure of the troop, which instills feelings of social uncertainly or weakness. In thermodynamic terms, the structural gap will force the troop system to evolve or reconfigure into a new bonding arrangement, which will correlate to a decrease in the Gibbs free energy of the system. In other words, in order for the group to keep 'working' properly, someone will have to assume the role of the alpha male. Again, in chemistry Gibbs free energy is a measure of this working energy.

To remedy this situation, system sensory stimuli in the troop, e.g. feelings of loss, mental weakness, social uneasiness, insecurity, etc., conveyed to each member subtly through unconscious situational language, will 'force' the next lower ranking beta male into the alpha role. To actuate this process, various sensor stimuli will activate select serotonin producing portions of the beta male's genome, i.e. switch them on, such that within a few days the beta male's confidence will rise, and he will fill the role of the alpha male.[32] In sum, system constraints reconfigure the atoms and molecules in the system towards an evolution path that will tend to lower the free energy of the system, i.e. stabilize it and thus keep it working. In this process, it was the initial photonic stimulus (trigger-action) to the sensor system of the initial alpha-male, causing (forcing) him to leave (or die), that initiated the system reaction, not each genes' self-serving purpose.

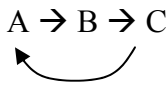
Contrary to this, is the current line of reasoning in the various evolution theories in which, for example, that bacterial life spontaneously arose from non-life about 3.85 billion years ago. From a biologist's perspective, Lynn Margulis, in the preface to her 1995 book *What is Life?,* co-written with Dorian Sagan, states 'Darwin taught us that all of life is descended from a single common ancestor.' On this, Margulis then presents the hypothesis that life evolved via an evolutionary mechanism of bacterial fusion occurring about 3.9 billion years ago, in which two separate bacteria united by a process symbiogenesis, i.e. two bacteria began to live symbiotically together. In chemical terms, this would be a combination reaction followed by a substrate-mediated transformation reaction:

$$B_1 + B_2 \rightarrow B_1B_2 \rightarrow B_3 \qquad [5.1]$$

According to this logic, the first entity of life on earth was a single magnificent little bacteria B_3 scooting about alone and autonomously in a world filled with non-living chemical precursors. This single bacterium, then, theoretically, split into two; these split into four, and so on. When taken on face value this logic seems to make a great deal of intuitive sense. The little bacteria, born from non-living chemical precursors, would subsequently grow, evolve, and transform into humans given time and the proper energy source. The problem here, essentially, is that a bacterium is a 15-element molecule; hence, prior to the formation of bacteria species there would have existed various reactive rudimentary species of 14-element pro-bacteria, and before that 13-element species, etc. In other words, are we to assume that these 'missing' 14-, 13-, and 12-element species were in some way dead?

Similarly, but more accurate from a chemical perspective, in the 1995 book *At Home in the Universe*, complexity theorist and biochemist Stuart Kauffman tells us 'most of my colleagues believe that life emerged simple and became complex. They picture nude RNA molecules replicating and replicating and eventually stumbling on and assembling all the complicated chemical machinery we find in a living cell. Most of the colleagues also believe that life is utterly dependent on the molecular logic of template replication, the A-T, G-C Watson-Crick paring.' Here Kauffman is pointing out the difficulty many have with the idea that RNA was the first life form.

The hypothesis Kauffman puts forward to resolve this issue, is that whenever a mix of atoms and molecules accumulate, there is a small chance that an autocatalytic reactive system, which can be thought of as a rudimentary type of self-maintaining and self-reproducing metabolism, will spring forth, and from this life will emerge. He states that life, at its roots, is the property of what is called 'catalytic closure' as proffered to be found amid heterogeneous collections of reacting molecular species. An autocatalytic system is one in which the end-products of a reaction function as a catalysis for the initial-reactants, i.e. one in which the molecules speed up the very reactions by which they themselves are formed: *A* makes *B*; *B* makes *C*; *C* makes *A* again, similar to following diagram:



Autocatalytic Closure

Hence, according to Kauffmann, 'alone, each molecular species is dead. Jointly, once catalytic closure among them is achieved, the collective system of molecules is alive.' Using this logic, Kauffmann reasons that past a certain critical threshold of molecular density, a web of catalyzed reactions emerges, which can be thought of as being alive. In his own words, 'as a threshold of diversity is crossed, a giant web of catalyzed reactions crystallizes in a phase transition.' In this view, to account for the

origin of life, Kauffman tells us, 'a critical diversity of molecules must be reached for the system to catch fire, for catalytic closure to be attained.'

This model, as we see, is very close to the correct answer. In reality, however, there is no such thing as a dead molecule. Every molecule, no matter what its state, will always possess a significant internal energetic subatomic life and will also be part of some variation of planetary, stellar, or galactic-scale atomic reaction cycle.[33] Furthermore, the concept of a self-sustaining chemical reaction that 'catches fire' and actuates on its own is paramount to arguing that there is such a thing as a perpetual mobile of the second kind, an argument that was shown to be fallacious in the late 19th century.[34] It is possible, to note, however, that Kaufmann's auto-catalysis reaction scheme would have likely played a significant role in long-term evolutionary chemical mechanisms, as it certainly does presently in many basic biochemical situations, but it certainly is not the starting point.

In 2003, to summarize the prevalent origin of life viewpoint, biochemist Paul Lurquin, in his *The Origins of Life and the Universe*, states 'since the mechanisms of life are basically identical across all species, it is legitimate to assume, as a working model, that all living creatures share a common ancestor, the progenitor of all life as we know it.' Lurquin then goes on to ask 'what was this progenitor and how did it appear?' According to Lurquin, who appears to have captured the general opinion on this topic, if we trace our steps back into history we will arrive at a very specific moment in history, in which we would be able to watch the formation of a very small grand-parent entity called the *progenitor*, from which all life sprang?

Originally, Darwin used the term *ur-organism* to define this hypothetical 'first life' species, from which all other life forms presumably evolved.[35] Later Darwin's ur-organism evolved into Oparin's *coacervate*, which is a spherical aggregation of lipid molecules making up a colloidal inclusion held together by hydrophobic forces, which can be thought of as a little ball of organic matter formed by the hydrophobic and hydrophilic actions of water. Moreover, Oparin correctly argued that there is no fundamental difference between a living organism and lifeless matter.[36] Recently, scientists have come to use the term *last universal ancestor* to define the hypothetical latest living organism from which all currently living organisms descended.[37] Again, this line of reasoning is fallacious. On any standard molecular evolution table, one will never find a so-called last universal ancestor; that is, unless one humorously assigns the hydrogen ion molecule H_2^+, the smallest molecule in the universe, to be the famed last universal ancestor.

In the 2005 book *Genesis – the Scientific Quest for Life's Origin*, geologist and earth scientist Robert Hazen tells us correctly that life results whenever energy flows through a molecular system and that this energy can drive such molecular systems toward ever more levels of complexity. Life on earth, according to Hazen, is a result of energy interactions among versatile carbon-based molecules. From these carbon-based systems, according to Hazen, come the emergence of larger molecular

structures, along with the selection, concentration, and assembly of life's membranes, proteins, and genetic molecules. Eventually, according to this logic, these biomolecular structures would form self-replicating cycles, or chemical systems that could copy themselves and compete for finite and dwindling supplies of resources. Ultimately, in Hazen's view, competition between different self-replicating cycles works to trigger evolution by natural selection, and subsequently the development of life. This is a very accurate depiction.

To elaborate on this picture, Hazen cites space biologist Gerald Joyce's working definition of life:

> "Life is a self-sustained chemical system capable of undergoing Darwinian evolution."
>
> – ***Gerald Joyce***, NASA Exobiology Panel [1994]

Hazen then declares, accurately, that 'any attempt to formulate an absolute definition that distinguishes life from non-life represents a false dichotomy.' The first cell did not just appear, according to Hazen, but rather arose through a sequence of emergent events, similar to how fossil records show that new evolved species have continuously emerged throughout history. First there was organic synthesis, then molecular selection and diversification, followed by increases in atomic complexity and further molecular evolution.

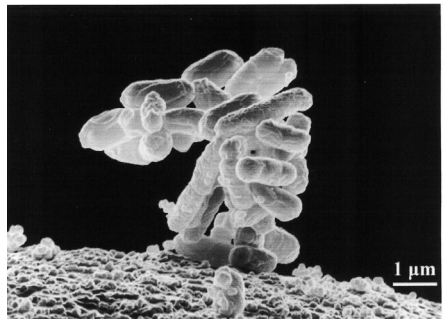
Moreover, 'what appears to us as a yawning divide between life and non-life,' according to Hazen, 'obscures the fact that the chemical evolution of life occurred in a stepwise sequence of successively more complex stages of emergence.' Hazen tells us that the basics of these steps began with a pre-biotic earth enriched with organic molecules, which then evolved to form functional clusters of molecules, perhaps arranged on a mineral surface, which assembled into larger self-replicating molecular systems that were able to copy themselves, then on to encapsulation in membranes, and finally to cellular life. Again, an excellent outline.

In 2005, in the encyclopedia *Universe*, we are told that biologists are agreed on a few basic features that distinguish life from non-life anywhere in the cosmos, in that, at a bare minimum, a living entity must be able to replicate itself, and over time, to evolve. Similarly, scientists generally agree that the beginnings of life on earth is linked to the accumulation of carbon-containing molecules and that these molecules originated from reactions of chemicals in the earth's atmosphere, stimulated by energy, such as lightning. In this early chemical system, we are given the hypothesis that: 'over millions of years the organic compounds reacted to form larger and more complex molecules, until a molecule appeared with the capacity to reproduce itself.'[38] By its nature, this 'progenitor molecule', which is characterized as a sort of rudimentary gene, became more common. Through mutations and the mechanism of natural selection, variants of this gene-like molecule would have developed more

sophisticated survival adaptations, eventually evolving into a bacterial-like cell, which, resultantly, would be the precursor to all life on earth.

This bacterial-like cell first life theory, coincidently, is remarkable similar to the view of the typical modern-day college student. In 2006, for example, when polled with the query: *'When did life begin and what did it look like?*, approximately 20% percent of people polled, aged 18-30, will give a theological-biased answer and 80% will give scientific-based answers.[39] The most common scientifically-reasoned answer is that life formed about 1-5 billion years ago in the form of a tiny cell, a single-celled microorganism, a bacteria, a small organism incased in a gel-cap, a single strand of DNA inside, or something similar to a small ameba, etc. Other more exotic answers given were that life began directly after the sun began to shine, that life began during the big universal explosion, that life began when the first water formed in the universe, or that life began 13-14 billion years ago in the form of raw energy or a combination of light and energy. One interesting answer was that life began *ad infinitum*; meaning that one cannot create something from nothing, in other words there's always been life.

From this discussion, generally, we should see that there is a perceptual blur in the dividing line between life and non-life.[40] In any event, using the current standard misconceived origin of life viewpoint, we should be able to find and label a very specific and particular organism and define it as the first life. Moreover, as we have established herein, all organisms are one of different varieties of chemical species, i.e. structures comprised of two or more atoms. Hence, in the history of the evolution of life there should have been one day in which there existed one particular little microorganism or chemical species, i.e. something visually similar to an aggregate *E. coli* bacteria, as shown below, having the properties of life:



Bacteria Molecule

$C_{E11}H_{E11}O_{E11}N_{E10}P_{E9}S_{E9}Ca_{E9}K_{E7}Cl_{E7}Na_{E7}Mg_{E7}Fe_{E6}Si_{E5}Mn_{E3}Co_{E3}$

This image is a low-temperature electron micrograph of a symbiotic cluster of about thirty *E. coli* bacteria, magnified 10,000 times.[41] Each individual bacterium in the cluster is oblong shaped. In a sense then, the above picture, according to current

scientific dogma, would be something similar to what would be the first form of life on earth. The standard evolution table, as we have discussed, however, shows this logic to be faulty.[9] In other words, it is inconceivable to think that, for example, a fifteen element molecule is in some way inherently different than a fourteen element molecule, or, for that matter, a thirteen or twelve element molecule, etc. The molecular evolution process is continuous and did not start with an amoeba, a single cell, a tiny bacterium, DNA, or RNA; atomic life started with formation of hydrogen.

The first to make this type of comparison was Hermann von Helmholtz, in a series of lectures delivered at the Carlsruhe in the winter of 1862-63, entitled 'On the Conservation of Force', where he made the comparison of a system of gas particles to that of a swarm of gnats. The particles, according to Helmholtz, probably cross one another in rectilinear paths in all directions, until, striking another particle, or against the side of a vessel, they are reflected in another direction.[42]

In late 1870s, a similar interesting molecular anthropomorphism was made by French meteorologist Antoni Poincare, in his book *On Science,* where in the chapter 'New Concepts of Matter' he made a comparison between the behavior of a cluster of midges, i.e. tiny dipteran flies, and a system of gas molecules. In modern terms, this would be a comparison between, for example, a collection of volatile carbon dioxide molecules CO_2, a system of two-element molecules, in a gaseous state to that of a collective of bees, i.e. systems of eighteen-element winged bio-molecules in an angered state.[43] A bee, in atomic composition, is a large eighteen-element molecule, no different than that of a volatile gas phase two-element molecule, such as a carbon dioxide molecule. The only inherent difference between each type of molecule is the complexity their various reactions, where complexity increases with element count.

An interesting observation in reference to the molecular evolution table comes from Italian physician Sebastiano Venturi, an expert in iodine deficiency, metabolism, and evolution research. Venturi notes that, according to his iodine research, the incorporation of atomic iodine into biological molecular structure, such as iodocarbons, may have began in *Cyanobacteria*, as a primitive antioxidant, probably about 3.5 BYA.[44] The current table, by contrast, does not list iodine *I* in the molecular formula for bacteria. In short, Venturi agrees with the structure of the molecular evolution, he only points out that further research will be needed to calculate more exact formulas and to find more exact elemental incorporation rates chronologically.

Another point of interest is that from certain known dates on the molecular evolution table, we can extract the reaction rate of elemental incorporation into living biomolecular mass. Specifically, based on the fact that many 4-element molecules exist in space as found in meteorites, e.g. cohenite $(FeNiCo)_3C$, meaning that at least four element molecules in size or greater would have existed when the earth formed, and knowing that basic fossil records indicate that 15-element prokaryote molecules,

e.g. bacteria, existed on the surface of the earth approximately 3.85 billion years ago, we can extrapolate various molecular evolution reaction rates.

In other words, if we assume that the early earth system at the exact age of 4.6 BYA, in a revolving atomic-molecular cloud-particle state, was composed of 92 elements, but that the size of all the molecules comprising its structure were only 4-element molecules or smaller, we can then show how long would it have theoretically taken an earth-bound reactive system of 4-element molecules, warmed daily by the sun and agitated daily via magnetic core rotation, to react together to form evolved or emergent systems or species of 5-element molecules. Similarly, we can figure out how many years would it take a system of 5-element molecules react to form systems of interactive 6-element molecular species, and so on. A simple calculation, using data from the table, shows that during the first 750 million years of the existence of the earth the reaction rate would have been 68 million years per element. This means that for each new evolved species, e.g. such as a new 7-seven element species evolved, over the years, from a reactive system of 6-element species, it would take 68 million years per super-element species generation.

By the 3.85 BYA mark, however, according to our data table, reaction rates seemed to have slowed down. At this point, according to mass composition data sets, many 15-element species were formed and fervently existing. Subsequently, to evolve a 15-element bacteria species into a 26-element human species would require the addition or incorporation of eleven new functional elements. The rate for this reaction process calculates to be 350 million years per element. In other words, every 350 million years a new extra-element species would have formed. To compound this issue, it is known that the earth goes through periodic extinction windows every 26 million years or so.[45] The effects of these extinction cycles, can be viewed as or thought of as a way in which the earth reactor tank is stirred up, thus allowing new reactant material to be added back into the system.

From this evolution table we see that the evolution of chemical species, deriving from hydrogen and helium atom precursors, is the result of a contiguous and gradual build up of molecular structure, through chemical reaction. Moreover, this buildup invariably is mechanized into action by the influx of solar thermal energy, the form of predominately gamma-ray photons γ, into the earth system, which has resulted in the evolved development of punctuated, interlinked, electromagnetically-driven, chemical reactions, which continue onward to this very day.

The current scientific view, to review, would have us believe that somewhere, in time, between the formation of 12-element *pro-bacteria molecule* (4.0 BYA) and the formation of 15-element *prokaryote molecule* (3.85 BYA), that on a very specific magical day something happened in which a source of energy, such as geothermal activity, lightning, intense solar phenomena, meteorite showers, etc., functions to set in motion the animation of molecular movement or life as we are so accustomed. In which, after this certain day the living molecule becomes autonomous.

What bears out of this logic, is the perspective that all molecular structures are, in fact, quite alive to various degrees. Furthermore, it is reasonable to assume that all fundamental particle structures, i.e. fermions and bosons, are quite alive as well to various degrees, when viewed from the appropriate resolution and temperature. When making this distinction, however, we must always be well aware that 'life' is a technical process and exact. In the laboratory, for instance, we can always make the very same reaction repeat over and over again, resulting in the exact same thermodynamic energy calculations, bonding rearrangements, intermediates, products, etc. In sum, these distinctions can be classified as quark life, atomic life, molecular life, and galactic life, and so on, in which the 'life' in question depends on the resolution of the microscope, telescope, or macroscope used.

As to classification, all biological species are chemical species, i.e. biological structures comprised of two or more atoms in which, as a soft guide, the numbers of currently identified biological species can be broken down as follows: 287,655 plants; 10,000 lichens; 1,190,200 invertebrates, including 950,000 insects; and 57,739 vertebrates, including 28,500 fishes, 5,743 amphibians, 8,163 reptiles, 9,917 birds, and 5,416 mammals.[46] Bacterial species, by comparison, are quite abundant; a single a single gram of rich, undisturbed soil may contain as many as 5,000 different species of bacteria.[47] The number of currently identifiable sub 15-element chemical species, however, i.e. molecular structures smaller than bacteria, is over 25 million.[48]

The new theory in human chemistry, used to account for linear atomic build up nature of the molecular evolution table, is that life is a continuous process of electromagnetically driven chemical reactions, in which chemically compatible molecules react with each other, via energy requisite mate recognition systems, to form new molecular structures of like but slightly differing atomic composition. This reaction process, from a human point of view, started when the accretion disc of matter began to accumulate, interactions that began before the sun ignited. Once the sun ignited, these reactions began to accelerate. In time, human molecules were formed.

Reproductively speaking, molecules or chemical species that react together have mate recognition systems, which are dependent on the energy and stability constraints of the reaction in relation to time. The determinants of mate-specific human chemical interactions (reactions), just as with simple chemical reactions, depend on *electronic interactions*, the attraction and repulsion of nuclei with valence charges as mediated by photons, and *stereochemical requirements*, i.e. the resultant synergy arising from the dynamic shape and fit of the molecules. These same two bonding determinants, according to Australian thermoeconomist James Reiss, from his 'Comparative Thermodynamics in Chemistry and Economics', in the 1994 book *Economics and Thermodynamics*, apply for human interactions. In this manner, for human molecules or otherwise, in the early years of the earth's formation, populations of 12-element molecules, for instance, over the course of a number of

years, would be electromagnetically forced to react together, over time, owing to similar mate recognition systems, to yield new 13-element molecules, i.e. a new chemical species. This process would have continued, eventually forming system of human molecules.

What is needed here is a *unified theory of evolution*, i.e. one that unifies the main theories of sociology, biology, chemistry, physics, and thermodynamics, in such a manner that atomic structural evolution is explained in an absolute seamless manner. A unified theory must account for firstly Boyle's principles and laws of chemistry (1661), second Darwin's theory of natural selection (1859), third Mendel's theory of genetic inheritance (1865), fourth Planck's quantum theory (1900), fifth Gibbs' theory of equilibrium thermodynamics (1957), i.e. Burton's biological free energy tables as found in Krebs and Kornberg's *Energy Transformations in Living Matter,* and six Gladyshev's thermodynamic theory of the evolution of living beings (1978). We will outline this assimilation in the following chapters.

The first person, however, to state the basic components of such a unified principle was Danish physicist Niels Bohr who in 1913 realized correctly that it is the geometric quantum energetic relationship between the positive nucleus and negative electrons that determines system evolution. This principle states, essentially, that systems tend to reconfigure in the direction that will miniumize the *internal energy* of the system. Bohr's principle is quantum mechanical and is structured on the works of the great Rudolf Clausius. The second person to state the basic components of such a unified principle was Russian physical chemist Georgi Gladyshev who in 1978 realized correctly that it is the spatial-temporal, geometric, thermodynamical relationship between the tendencies underlying the work output of molecular systems as these tendencies relate to the system stabilities that determines evolution. This principle states, essentially, that systems tend to reconfigure in the direction that will minimize the *free energy* of the system. Gladyshev's principle is thermodynamical and is structured also on the works of the great Rudolf Clausius.

Both principles are the same, only one is microscopically-based and the other is macroscopically-based. Bohr's principle was stated verbally; Gladyshev's principle, however, was stated mathematically. In short, when the earth is divided up into the correct systems-within-systems delineation, evolution within each isothermal, isobaric subsystem, per each equilibrium *relaxation window*, occurs or progresses such that the value of the Gibbs free energy per unit subsystem volume tends to a minimum:[49]

$$G = \frac{1}{V}\int_0^V \frac{\partial G}{\partial m}(x,y,z)dxdydz \rightarrow \min \qquad [5.2]$$

In the chapters to follow, it will be shown how these two principles coexist.

On shorter time-scales, the evolution of molecular species can be understood in terms of site specific free energy binding tendencies. Short evolutions are comprised

of chemical reaction mechanisms. Basic sets of short-evolutions add up over time to form multi-year evolution-cycles. Together, evolution-cycles link up to describe the total evolution process that defines the life of the earth coupled to the solar system. In this direction, to give an outline of how evolution occurs dynamically, i.e. functions mechanistically, in short-evolutions we will examine a few current models of small-scale molecular dynamics, such as receptor-ligand binding interactions.

Human molecular dynamics

Humans, by definition, are molecules, attached to substrate, which react selectively together, over evolutionary time periods, and that in each selective, temporally permeable, subsystem the natural evolution tendency or behavior of human chemical species is towards the minimization of Gibbs free energy. This principle holds for all molecular interactions in evolving isothermal, isobaric reacting systems. In other words, the Gibbs free energy function is a direct fusion of the four laws of chemical thermodynamics and provides a basis for a quantitative index of the potential ability of a substance, molecular structure, or system to undergo a physical or chemical transformation.[50]

This is all fine, except from a technical standpoint what do these statements have to do with the process of two people falling in love?

> “Love at first sight is not just a cliché ...
> a *chemical reaction*, which may lead to romance, can be
> created when one person first looks at another.”
>
> *Nuna Alberts* – Love Science Researcher, Saddleback College[51]

To answer this fascinating question, we must first study the processes, behaviors, and dynamics, in which small molecules unite, bind, react, and, in their own unique way, fall in love. That is, just as human molecules, i.e. big molecules, evolved from small chemical systems, so to did the phenomena or process of love (intense attraction), as well the act or process of intense hatred (intense repulsion), evolve from atomic-molecular interactions in small chemical systems. Thus, if we were to study interactive proteins, which are semi-large six-element molecules, their bonded complexes, interactive associations, and dynamics, we might discern patterns, behaviors, and laws applicable to our own life.

Proteins, themselves, were recognized as a distinct class of biological molecules in the eighteenth century by French chemist Antoine Fourcroy and others. Members of this class, called the ‘albuminoids’, were recognized by their ability to coagulate or flocculate under various treatments such as heat or acid; well-known examples at the start of the nineteenth century included albumen from egg whites, blood serum albumin, fibrin, and wheat gluten. The similarity between the cooking of egg whites

and the curdling of milk was recognized even in ancient times; for example, the name 'albumen' for the egg-white protein was coined by Pliny the Elder from the Latin *albus ovi* (egg white).[52]

In the beginning of 19th century, with the advice of Swedish chemist Jöns Jakob Berzelius, Dutch chemist Gerhardus Johannes Mulder carried out elemental analyses of common animal and plant proteins. To everyone's surprise, all proteins had nearly the same empirical formula, roughly $C_{400}H_{620}N_{100}O_{120}P_nS_m$, where subscripts *n* and *m* are constants which vary per protein. In 1937, Mulder published his findings in which he hypothesized that there was one basic substance ('Grundstoff') of proteins, and that it was synthesized by plants and absorbed from them by animals in digestion. Berzelius was an early proponent of this theory and proposed the name *protein* for this substance in a letter dated July 10, 1838: 'the name protein that I propose for the organic oxide of fibrin and albumin, I wanted to derive from Greek word *πρωτειος*, because it appears to be the primitive or principal substance of animal nutrition.'[52]

All proteins, subsequently, are six-element dynamic molecules evolutionarily related to larger twenty-six-element human molecules. Moreover, being that human molecules evolved (or are related), in a round-about-way, from protein molecules, similar behaviors should be apparent. According to Danish quantum chemist John Avery, protein conformational changes, enzyme-substrate dynamics, antigen-antibody interactions, and sub-cellular organelle autoassembly processes all take place along paths that minimize the Gibbs free energy of the system.[53] Likewise, according to Russian physical chemist Georgi Gladyshev, the ontogenetic and phylogenetic development at any stage in the development of an organism, as well as the evolution of social systems of organisms, takes place along paths that tend to minimize the Gibbs free energy of the system.[54]

In evolving protein systems, such as in autoassembly, protein folding, and other known scientific processes, complementary charges are drawn towards each other, not along paths that minimize the energy of the system, but along paths that minimize Gibbs free energy.[53] Likewise, humans, in evolving molecular systems, are drawn along paths that minimize the Gibbs free energy. In the protein system, the entropy term plays the essential role between two opposite charges, the water molecules are aligned, and their entropy is lower than it would be if they could move around freely. As the opposite charges approach each other, the volume of the structured water between them is reduced, and the entropy of the system increases.

Similarly, thermodynamic models of drug-receptor interactions show that the chemical affinity of a *ligand* or binding molecule toward a *receptor* or binding site falls into an energy range of -10 and -80 kJ mol^{-1}. These values relate to a binding constant and correspond to a Gibbs free energy. The *binding constant* is a special case of the equilibrium constant that represents the tendencies of the attachment molecule to either bond or debond from the attachment site. Accordingly, enthalpic

and entropic effects determine binding affinity.[50] This process, by extrapolation, is analogous to how, stereotypically, a single free female human molecule migrates towards the stable bonding structure of a male human molecule together with his occupational environment and his living arrangements. The converse situation may occur as well, i.e. a single free male may attach to a female's occupational site.

In the animal kingdom, as another example, bird mating grounds called *leks* operate according to these same principles.[55] During bird mating season, a Saturday-night circular cruising strip called a 'lek' forms, in which male birds establish a territory among the other males, with those more dominate in the hierarchy located towards the center. The females then, being similar to ligands, migrate to and selectively attach and bind onto specific male lek patches. Subsequently, whether it is with ligands, birds, or humans, different Gibbs free energy values correlate with each specific binding site, some more or less stable than others.

Moreover, a relatively new computational mapping technique of thermodynamic affinities of receptor-ligand pairs, prior to the interdigitation of their surfaces, reveals two mechanisms of protein-protein recognition, one dominated by long-range, i.e. nanoscale, electronic steering and the other by short-range, i.e. less than two water layers, desolvation forces.[50] When two attracting macromolecules intertwine the resultant semi-stable structure is called an 'encounter complex'. In this process, there are two electrostatic effects, one long range, one short range, which guide molecules to each other. Subsequently, binding entails, at least for one of the molecules, a diffusional search for its target.[50] This same process occurs spontaneously in human life, such as in bars and nightclubs.

In these molecular diffusional or searching processes, there exist both strong and weak long-range steering forces, as well as short-range 'locking potentials'.[56] In human terms, these short-range locking potentials may be equivalent to knowing that a mate is 'the one', among a pool of potentials, and the spontaneous intercourse, i.e. atomic exchange (sex), intense relationship bonding, and productive work output to follow.

Each molecular movement or behavior, in relation to other molecules, is associated with either an attractive energy or a repulsive energy. The sum of the electrostatic and desolvation free energy of encounter complexes in the binding pocket, for example, is about -6 kcal mol^{-1} or less, whereas on average the non-specific association free energy is repulsive to the order of 1-2 kcal mol^{-1}. It is estimated that this partial affinity is sufficient to over come the entropic barrier associated with the loss of rotational and translational degrees of freedom upon binding. On the other had, the overall repulsion, dominated by desolvation forces is enough to restrict non-specific association to a minimum.[50]

In the human molecular scenario, entropic barriers associated with the loss of rotational and translational degrees of freedom upon binding are related to, for instance, the bonds one has to break or reconfigure during romantic transformations.

If, for example, a potential locking pair has conflicting activity orbitals (see chapter nine), such as polar opposite side-friendships that don't mix well into each other's networks, or the loss of a favorite rotational activity orbital, e.g. one is forced to quit their weekly hobby, or the pair have incongruent distant occupational sites, etc., then these dynamics create entropic barriers to binding. Similarly, in-law conflicts or friendship tensions can result to be entropic barriers to binding. Marriage entails bonding not just to a spouse but to the partner's entire family. If a husband, for example, chooses to side with his mother over his wife on issues, such as who chooses dinner arrangements, the result will be entropic tensions or energy barriers to a successful marriage. Martial discord problems associated with strained or incompatibly interfamilial relationships are one the top-seven most sited reasons for divorce.[57]

In a more technical manner, using protein-macromolecular dynamic systems as an example, the relative orientation of two molecules in an encounter complex can be specified by five Euler angles. Using these measurements, a *free energy map* or landscape can be obtained which is a continuous function in the space of these five variables, obtained by smoothing the discrete free energy values on a grid of the surface of the receptor. These maps, which extend the concept of affinity between macromolecules beyond structural complementarity, can be used to identify regions of low electrostatic or desolvation free energy.[58] From a physical point of view, these thermodynamic free energy landscapes correspond to the sensory force fields guiding the orientation alignment of the macromolecules by the diffusion of proteins at close proximity.[50]

Thermodynamically, 'free energy maps' are essentially the same thing as mate-selection psychological 'love maps', a concept developed in the 1980s by American psychologist John Money.[59] Mental lovemaps, according to Money, are 'a developmental representation or template in the mind and in the brain depicting the idealized lover and the idealized program of sexuoerotic activity projected in imagery or actually engaged in with that lover.'[60]

A lovemap can be shaped by both positive and negative factors such as things that function to either attract or repel the person whose exacting erotic, physical, mental, intellectual, and emotional tastes are being mapped. For reasons that are not always easy to understand, one person may be attracted to people of a particular gender, with a particular physical characteristic, with particular personality traits, and so forth. One may also find certain characteristics so threatening or objectionable that it strongly mitigates against an erotic reaction being manifested. A lovemap is also shaped by environmental factors, which can either function to facilitate the formation of an erotic bond, or that can enhance or diminish an erotic response. Some people, for instance, may bond strongly to people with whom they share a crisis situation. Others may find their erotic responses muted in the presence of intimidating environmental factors, e.g. observant elders or nosy neighbors.

The word 'lovemap' was first used in 1980 in an article entitled: 'Pairbonding and Limerence'. Before this time, Money began talking about lovemaps, in precursory form, with his students in lectures, where he used the word love-blot as follows: 'there is a rather sophisticated riddle about what a boyfriend (or girlfriend) and a Rorschach inkblot have in common. The answer is that you project an image of your own onto each. In many instances, a person does not fall in love with a partner, per se, but with a partner as a Rorschach love-blot. That is to say, the person projects onto the partner an idealized and highly idiosyncratic image that diverges from the image of that partner as perceived by other people. Hence the popular idiom that love is blind, for a lover projects onto a partner, or love-blot, his or her unique love image, as unique as his or her own face or finger print.'[59]

Moreover, according to Money, like the acquirement of a native language, a person's lovemap also bears the mark of his or her own unique individuality, or accent. A lovemap is usually quite specific as to details of the physiognomy, build, race, and color of the ideal lover, not to mention temperament, manner, etc. Thus, the energetic analog to a love map is a free energy map, which corresponds to the sensory forces that guide the orientation, alignment, and development of a person's life in proportion to measurements of neighboring 'locking potentials' of human molecules in close proximity. Thus, in human life, forces or locking potentials drive the search leading to high-affinity binding of humans to other humans.

The insights unveiled by free energy landscapes, and supported by simulations, indicate that selected intermolecular collisions, near binding sites, are weakly specific, meaning that some binding sites are energetically preferred over others.[61] It is argued that once long-range electrostatic forces steer binding molecules, such as ligands or human molecules, into its attractive pocket or region on the free energy map, desolvation forces further steer the binding molecule toward a local free energy minimum.[62] Moreover, these glide paths can be in terms of angle of approach, each with a correlative attractive or repulsive energy associated with it. The classic model, showing the four distinct steps in the reaction between two proteins *R* and *L*, is shown below:[62]

$$\underset{\text{"close proximity"}}{R + L} \quad \leftrightarrow \quad \underset{\text{"encounter complex"}}{R \cdots L} \quad \leftrightarrow \quad \underset{\text{"transition state"}}{R - L} \quad \leftrightarrow \quad \underset{\text{"bound state"}}{RL} \qquad [5.3]$$

The first step in the reaction, $R + L$, brings the two protein molecules into close proximity, resulting in the first 'macrocollision' and yielding the *encounter complex*: $R \cdots L$. In the second step, short range electrostatic effects result in a well-oriented conformation called the 'transition state' or $R - L$. At this point, orbital overlap effects are not yet significant factors. The last step of the binding process is the latter stage transition from the favorable intermediates to the bound state unit *RL*. This is a

process of induced fit, limited by a rate constant, which requires structural rearrangements overcoming mostly enthalpic energy barriers.[50]

The decomposition of [5.3], for example, of a protein-protein binding interaction process into attractive and repulsive free energy measures per interaction factor can be broken down into specific components of as follows:[63]

$$\Delta G_{total} = \Delta E_{coul} + \Delta G_{polar} + \Delta G_{non\text{-}polar} - T\Delta S_{SC} + \Delta G_{rot\text{-}trans} \qquad [5.4]$$

Here, ΔE_{coul} is the direct electrostatic energy, ΔG_{polar} is the self-energy change upon desolvating the charge on polar atom groups, $\Delta G_{non\text{-}polar}$ is the free energy change of transferring non-polar atoms from the solvent to a protein environment, ΔS_{SC} is the side-chain entropy loss, and $\Delta G_{rot\text{-}trans}$ includes mainly the rotational and translational entropy change of the two proteins forming a single complex and all other terms in the free energy.[50] The $\Delta G_{rot\text{-}trans}$, to note, functions as a 'repulsive interaction' and has been estimated to be 10-15 kcal mol^{-1}. Positive values of Gibbs free energy change ΔG, to review, indicate a non-favored reaction, interaction, or process; however, as long as the total Gibbs free energy change ΔG_{total} is negative, the total process will be favored. Models similar to [5.4] for human molecular interactions, in which each significant 'energy interaction' in a person's life, on their unique free energy map, can be assigned free energy change values similar to the above model, but also qualified in human terms.

In Gladyshev's famous 1978 hierarchical Gibbsian thermodynamic theory of biological evolution, for example, he shows that by dividing evolving systems into individual components or quasi-closed reactive systems, that one can use Gibb's criteria of equilibrium and methods of classical thermodynamics to predict the course of particular evolutions.[49] In short, Gladyshev states that by using the 1876 physical chemistry methods of Willard Gibbs, it is possible to analyze bioevolution using the notion of 'evolution potentials', being analogous to chemical potentials. Gladyshev then brilliantly states that the total change in the Gibbs free energy of the biosphere (bs) can be given by the expression:

$$\Delta G_{bs} = \Delta G_{at} + \Delta G_{m} + \Delta G_{im} + \ldots + \Delta G_{pop} + \Delta G_{soc} + \Delta G_{eco} \qquad [5.5]$$

in which the subscripts, *at* = atomic, *m* = molecular, *im* = inter-molecular or super-molecular, *pop* = population, *soc* = social system, and *eco* = ecosystem, refer to the particular evolution tendency within each subsystem. Thus, according to Gladyshev, for example, 'ΔG_{pop} will relate to the total change in the Gibbs free energy of a population and to changes in the Gibbs free energy due to chemical transformations of the molecules of that population in the course of evolution respectively.' These statements, as we see, are well ahead of their time. In the next chapter, to note, we will show that within the energetics associated with the dynamics of marriage, there

must exist at least a five-to-one ratio of attractive-to-repulsive interactions if the marriage process is to work. This example is just one of many reaction models that functions as a basic structure on which to study and model human molecular reaction dynamics.

In this direction, according to theoretical chemist John Avery, from his 2003 book *Information Theory and Evolution*, 'when two molecules fit closely together, with their physical contours matching, and with complementary patterns of excess charge also matching, the Gibbs free energy of the total system is minimized.' In human life, this correlates to the pair-matching process in which the physical and mental components of the two bonding human molecules fit together in a complementary and congruent ways. This is a basic generalized human chemical thermodynamic way or description to energetically quantify the process of falling in love. All chemical reactions actuate, according to Avery, such that 'the self-assembly of matching components proceeds spontaneously, just as every other chemical reaction proceeds spontaneously when the difference in Gibbs free energy between the products and reactants is negative.'

This organizational tendency towards the minimization of Gibbs free energy of bio-molecular structures such as humans, according to Avery, is the most important universal mechanism of biology. Chemical reactions take place spontaneously when the change in Gibbs free energy produced by the reaction is negative; moreover, being that expression [4.11] accounts for the effects of entropy change ΔS, chemical reactions also take place in such a direction that the entropy of the universe increases, as stipulated by the second law of thermodynamics [4.4]. This statement, however, does not imply that the universe will invariably become more disorganized; instead, it takes into account the fact that there is a quantifiable amount of transformation-energy or dissipation-energy associated with the process of evolution. In this manner, when spontaneous chemical reactions take place, the universe moves from a less probable configuration to a more probable one. The same principle controls the motion of larger systems, where molecules arrange themselves spontaneously to form supramolecular structures. Collections of molecules move in such a way as to minimize their Gibbs free energy, thus maximizing the entropy of the universe.[64]

Biological structures of all kinds are formed spontaneously from their base components because assembly information is written onto their joining surfaces in the form of complementary surface contours and complementary patterns of excess charge, much like the coding of a DNA chain. Matching pieces fit together, and the Gibbs free energy of the system is minimized. Virtually every structure observed in biology is formed in this way.[65] Thus, whenever human molecules are thrown together into a system, they will tend to evolve interactively, over time, by matching mental and physical structures in such a manner so as to resultantly lower the Gibbs free energy of each respective system.

6 – Attraction and Repulsion:

"There's a force in the universe that makes things happen and all you have to do is get in touch with it, stop thinking, let things happen, and be the ball."

Chevy Chase, *Caddyshack*

In the preface section to the 1686 *Principia*, the great English mathematician and physicist Isaac Newton declared that the phenomena of nature, aside from celestial motion, derives from the effects of certain forces of nature that cause bodies to either attract impulsively so to cohere in regular figures or to repel impulsively from each other in distancing arrangements. To clarify the essential meaning of the words 'attraction' and 'repulsion', according to the founder of electromagnetic theory Scottish physicist James Maxwell, from his 1877 treatise *Matter and Motion*:

> Mutual action between distant bodies is called *attraction* when it tends to bring them nearer and *repulsion* when it tends to separate them.

In the chemical composition of any interpersonal relationship, there will always exist facets of both attraction and repulsion. Attractive interactions, as discussed, are quantified by negative values of Gibbs free energy change, whereas repulsive interactions are quantified by positive values of Gibbs free energy change. The detailed mechanisms of these human interactions are quantum electromagnetic in composition and underlying basis.[1] In mutually agreeable relationships, attraction and repulsion function together in such a manner so as to stabilize the bond. At times, however, in the decision making process, the neurological resultant effects of these dynamic quantities will pull equally in opposite directions so to create a state of mental ambivalence, uncertainty, or indecision. The term 'ambivalence' was introduced in 1911 by the Swiss psychiatrist Eugen Bleuler to characterize a state of simultaneous conflicting emotions, such as having combined feelings of both love and hatred for another person.

In interpersonal romantic relationships, according to the research of Meredith Broussard, states of mental ambivalence are associated with simultaneous and contradictory attitudes or feelings, such as *attraction* and *repulsion*, toward an object, person, or action.[2] Such feelings may be constant in a relationship and may result in a continual fluctuation between on thing and its polar opposite. In many cases, ambivalence precedes uncertainty in regards to which approach or decision to

follow; especially in the days preceding a relationship breakup.[3] Statistically, couples in which one or both partners mention any feelings of ambivalence are three times as likely to divorce within four years.[4]

Situated on either side of the *ambivalence point* on the attraction (like) to repulsion (dislike) scale are, on one side, that of extreme reluctance, i.e. repulsion, towards someone or something and, on the other side, that of extreme inclination, i.e. attraction, towards someone or something. Together, combinations of attraction, repulsion, and ambivalence function synergistically so to create mental and physical reaction states of all emotions and decisions.

In terms of measurements of human potential, mate value, or sexual quality, all interpersonal human traits, qualities, or definers can be divided into two specific attribute types: *physical attractors*, such as size, shape, smell, symmetry, averageness, phenotype, youthfulness, immune system function, strength, vigor, health, physique, thinness, complexion, etc., and *neurological attractors*, such as intellect, humor, honesty, sincerity, drive, vocation, elegance, ambition, sociability, wealth, wit, class, prestige, etc.[5] These 'attractors', in the reverse sense, may also function as 'repulsors'. One person's humor may be another's irritation. Together, these sets of personal attractors and repulsors interact to yield an innate measure of a person's total perceptual beauty.[6] This powerful quantity can be measured on an individual basis, i.e. in the eye of the beholder, or according to consensus, e.g. mean value.[7]

In a typical interpersonal interaction, particularly in romantic or dating potential situations, physical attractors tend to be noticed first.[6] Once neurological attributes, such as occupational information, intellect, educational level, conversation aptitude, mental resilience, network information, character, inner quality, sociability, humor, financial data, social status, etc., begin to be discerned, however, the total perceptual value of a person's innate beauty or total molecular attractiveness begins to change instantaneously.[8] True change, however, requires the release of nerve growth factors NGF, which release seven times daily and once dominantly during REM sleep when a person dreams deeply. *Nerve growth factors* are secreted proteins that function to induce the differentiation and survival of particular target neurons. [9]

Studies have shown that people newly in love have higher plasma NGF levels than as compared to people in other groups, such as those not in relationships or those in long-term relationships. It is not clear, specifically, how the process of falling in love triggers higher levels of NGF, but it is generally agreed that this growth-inducing protein plays an important role in the process of 'social chemistry', especially at the start of any particular relationship.[10] In a recent 2006 *Journal of Psychoneuroendochrinology* article, Italian researchers found not only that those in the initial stages of romance have higher plasma levels of NGF as compared to those in long-term relationships or those not in relationships, but that there is a significant positive correlation between levels of NGF and the intensity of romantic love as

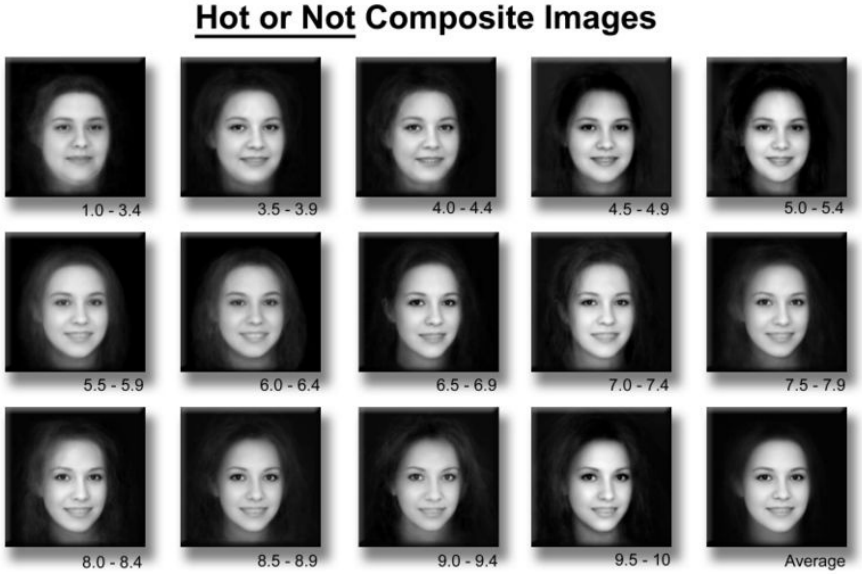
assessed on a passionate love scale.[11] Researchers characterize this as a 'mental state' that subsides after being in a relationship for a period of 12-24 months.

These mental growth transition windows allow for central nervous system CNS structural reconfigurations, which are directed by the day's sensory inputs. Hence, neurologically, in time, a frog can magically transform before a person's eyes into a handsome prince, and a stunning beauty queen can transmogrify into ugly hag.[12] This transformation aspect of relationships was captured brilliantly in the 2001 romantic comedy film *Shallow Hal* starring Gwyneth Paltrow, Jack Black and Jason Alexander. This was also described as *crystallization* by French writer Stendhal in his famous 1821 book *On Love*. In chemical terms, these beauty transformation aspects are quantified by visual or neurological entropy force effects. Interpersonal chemical attractiveness, subsequently, is a combined function of both physical attributes and neurological attributes, which change per microsecond of interaction.

Men and women tend to select for traits differently. Men, on average, tend to select highly for physical factors, whereas women, on average, tend to select highly for neurological factors.[13] One quality, for men especially, that of first-impression visual attraction, i.e. without known anything about the person or having heard them speak, seen them move, or watch them react, etc., is a powerful factor in human reactions. Decisive features of female physical appearance, from the male perspective, include those such as full lips, clear and smooth skin, skin tone and color, clear eyes, eye lash health and thickness, eye color, nose size and shape, jaw line, chin structure, straight dentition, lustrous hair, hair color, hairlessness, fitness, good muscle tone, chest size, chest shape, waist-to-hip ratio, buttocks fullness and firmness, leg shape, nail health, body fat percent, weight, height, and girth. Other dominate factors include, body type, i.e. apple, pear, or hourglass, golden ratios of facial and body morphology, as well as generalized quantifiers such as youthfulness, averageness, and symmetry.[14]

In most cases, in regards to sexual attraction and repulsion tendencies, there will always be an exact discernable underlying reason for mate preferences. The hourglass shape, for example, even though only a rare eight percent of all females possess this body type, is the most coveted. In any random sample of women, the following body shapes will occur: rectangle (46.1%), spoon (20.9%), inverted triangle (13.8%), hour glass (8.4%), and other (10.8%).[14] The underlying reason, aside from basic birthing concerns, that non-hourglass figures are less-preferred, those such as egg-shaped, pear-shaped, or stick-shaped women, according to mate selection researcher Helen Fisher, from her 2004 book *Why We Love – the Nature and Chemistry of Romantic Love*, is that women with these shapes suffer more from chronic diseases, such as diabetes, hypertension, heart disease, circulation problems, certain cancers, and are prone to various personality disorders. In most cases, where a physical trait is deemed as repulsive, there will be a simple underlying biological explanation.

To provide a rough estimate of a standard 1-10 average physical attractiveness scale, shown below are ten morphed composite photographs of thirty women, three per image, selected at random from *hotornot.com*.[15] Composite photographs tend to exemplify the 'averageness' factor, i.e. the more averaged a person or photograph is the more attractive it is, which is a physical quality related to phenotypic stability.[16]



Physical attractiveness is a powerful factor. Physical attractiveness is the only factor shown to be effective in determining the success on a blind date.[17] Studies show, for example, as based on a 1-10 rating scale, that 60 percent of couples at social events are separated by only one point of physical attractiveness, and that 85 percent are separated by two points or less.[18] In other words, if one is a '5' in average physical attractiveness, there is an eighty-five percent chance that he or she will tend to bond well with others in the 3-7 range.

For women, a strong neurological attractor, in human bonding, is that of a man's vocation, occupation, or working function in society. A lack thereof, conversely, functions as a strong repulsor. In America, for instance, when women make more money than their husbands or when their husbands are jobless, they tend to leave them.[13] One study found that the divorce rate among American couples in which the woman earns more than her husband is 50 percent higher than among couples in which the husband earns more than the wife.[19]

Certain occupations are preferred more than others. In arranged marriages, and in general with all families, doctors, lawyers, and engineers are favored grooms.[20] Conversely, as people derogatorily tend to point out, occupations such in trash collectors, fast-food workers, hookers, unemployment, non-employment, or homelessness, etc., make for unfavored mates. Many will argue that these are only

stereotypical labels and that it makes no difference what one does with his or her life as long as they are a decent person. The answer to this *occupation puzzle*, however, goes much deeper. What a person does with their life, good or bad, has energy satiety consequences; and has to do with stability tendencies of evolving systems as regulated by the combined law of thermodynamics. This is a topic requiring further discussion.

In a related 1994 study conducted by American evolutionary psychologists David Buss and Jennifer Semmelroth, one-hundred-and-four college women were asked how flattered they would feel by outright sexual propositions by various occupied men, on a scale of *7 = most upset* to *1 = least upset*. The study found, essentially, that women would be most upset by advances from construction workers (4.04), garbage collectors (4.32), cleaning men (4.19), and gas station attendants (4.13), and least upset by premedical students (2.65), graduate students (2.80), and successful rock stars (2.71).[13] In a similar 2003 study, forty-nine college-aged women were shown a randomized list of fifty highly-attractive occupations for a man to have and were asked to pick the best three to marry.[21] The top 10 best picks are shown below:

#	**Best to Marry**	**Votes** (1st, 2nd, 3rd pick)
1	Doctor (top-5 Medical School)	1,1,1,1,1,1,1,1,2,2,3,3
2	Movie Star (Academy Award Winner)	1,1,2,2,2,2,2,2,3,3,3
3	Engineer (top-5 Engineering School)	1,1,1,2,2,2,3,3,3,3,3,
4	Architect (top-5 Architectural School)	1,1,1,2,2,2,2,2,3
5	Rock / Music Star (Grammy Winner)	1,1,1,1,2,2,3,3
6	Neurosurgeon	1,1,1,2,2,3,3,3
7	World-Renowned Chef	1,1,2,3,3,2,3
8	Sports Star (NBA, NFL, NHL, PGA, etc.)	1,1,1,2,2,2
9	University Professor (highly-respected)	1,1,2,2,3,3
10	Lawyer (top-5 Law School)	1,1,2,2,3

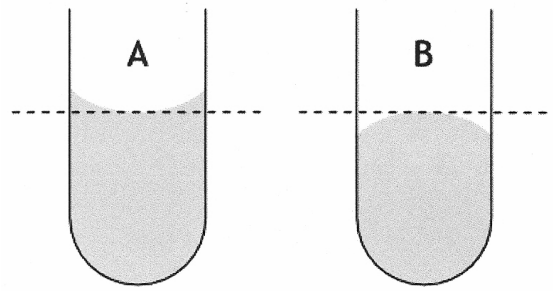
On the opposite end of the scale, a related 2006 study determined the most repulsive jobs to marry into. In this study, forty college-aged men and women were asked to pick the worst jobs to have.[22] The conditional term 'worst' was specified primarily in terms of sexual selection perspectives, but also with reference to psychological effects, physicalities, stress, long-term effects, peer pressure, social perspectives, and family prerogatives. In other words, survey participants were essentially instructed to select the worst jobs as based on the perspective that they wouldn't want to date or marry a person if they had that job. The top 10 worst jobs to have, based on the above specifications, which essentially amount to a sexual selection perspective, are shown in the following table; vote counts are shown in the right column:

#	Worst to Marry	Votes
1	Stripper, Poll Dancer	16
2	Garbage Collector, Trash Compactor Cleaner	16
3	Hooker, Prostitute, Escort	14
4	Janitor, Bathroom Attendant, Custodian, Event Cleanup Crews	12
5	Fast Food Worker, Fast Food Drive Thru, Fast Food Cook	10
6	Waste Sewage Cleaner, Septic Tank Cleaner	9
7	Server	9
8	Porn Star	8
9	Drug Dealer, Class A Drug Dealer	5
10	Factory Worker, Shipping and Receiving, Box Stacker	4

Vocation or occupation, certainly, is only one of numerous mate traits, such as personality, character, class, sense of humor, etc., that make up a person's total neurological attractiveness; nevertheless, it is a dominant one, e.g. it characterizes 36 percent of a person's waking-hours; and as we have shown is an important factor in substrate attachment. One might argue that love is the most important factor in human life, yet correctly it is the work derived out of the various love-hate processes that is the paramount issue. Daily, weekly, monthly, seasonally, and yearly molecular work-output is an evitable consequence of the fact that the earth is situated between a hot body, the sun, and a cold body, space at night, as per the laws of chemical thermodynamics.

Occupations that are extremely attractive to marry into are perceptually deemed as such essentially because they are extremely stable in the long term, and as such in alignment with basic thermodynamic free energy tendencies. Thermodynamic studies of molecular systems show that a basic or inherent tendency of evolving molecular systems is to migrate towards dynamic configurations of stability, often called point attractors (free energy wells). In human terms, physicians are point attractors for many women just as supermodels are point attractors for many men.

A simple example to illustrate the effects of attraction and repulsion between molecules is the liquid surface curvature effect called meniscus. When a system of liquid molecules, such as water or mercury, is poured in a container, such as a glass test tube, the molecules will initially be set out of mechanical equilibrium with their surroundings, i.e. the glass container. Given time, however, the system of molecules will evolve towards a new configuration of stability. If the molecules of the liquid 'attract' the molecules of the container or object, as is the case between water and glass, a concave meniscus, i.e. valley-type shape (A), forms on the surface of the liquid. If the molecules of the liquid 'repel' the molecules of the container or object, as is the case between mercury and glass, a convex meniscus, i.e. hill-type shape (B), forms on the surface of the liquid.[23] This effect is shown below:



Liquid molecules attracted to the molecules of the container forming a *concave meniscus* (A); liquid molecules repelled by the molecules of the container forming a convex meniscus (B).

These same effects occur in human molecular systems. Moreover, these types of dynamic inter-molecular attractions and repulsions can be mapped, for example, in chemical thermodynamic terms, such as by using free energy maps.[24] In biological systems, free energy [4.9] is a function of enthalpy H and entropy S. As entropy is a function of neurological beauty, as we have shown, it is very likely that enthalpy is a function of physical beauty.[25]

Subsequently, according to this thermodynamic logic, we will postulate that human molecular physical attractiveness A_P is a function of enthalpy H and that human molecular neurological attractiveness A_N is a function of entropy S. These assignments, however, are only approximate. In formulaic terms, whatever the case, the measure of a person's total attractiveness A_T or beauty can be defined by the following expression:

$$A_T = A_P + A_N \qquad [6.1]$$

Similarly, the measure of a person's total repulsiveness R_T or ugliness can be defined by the following expression:

$$R_T = R_P + R_N \qquad [6.2]$$

With these equations, we will show that human chemical bonding is a function of attraction and repulsion or of both [6.1] and [6.2], namely:

$$Bonding = f(A_T, R_T) \qquad [6.3]$$

Equation [6.3] holds for both basic chemical bonding and advanced human chemical bonding.[26] These expressions, invariably, become more complicated when defined in thermodynamic terms. In chemistry, however, enthalpy H is a heating factor and entropy S is an organizational factor, both of which act in a competitive manner as

separate thermal 'driving forces' in chemical reactions.[27] This energy distinction or phenomenon is commonly referred to when people ask the query 'why beauty and brains don't come in the same package.' The answer is that both beauty and brains are different energetic quantities. At a dull party, for example, someone who is extremely beautiful can walk in and make the whole party come 'alive'; likewise, someone who is extremely funny, witty, clever, or intelligent, etc., can walk in and make the whole party come 'alive'.

In short, approximations aside, enthalpic ΔH and entropic ΔS measures of interpersonal physical and neurological attractiveness, together with external work functions, that may be affecting a relationship, yield quantitative values of the Gibb free energy change [4.11] for each human chemical reaction. These essential relationships are a core subject of human chemical thermodynamics, and will only be dealt with tersely herein. To review, Gibbs free energy change ΔG, being sum of the enthalpic ΔH and entropic ΔS forces, determines the 'spontaneity' of the reaction:

Spontaneity – proceeding from natural feeling or native tendency without external constraint.[28]

In typical human chemical relationship reactions, good romantic relationships tend to occur *spontaneously*. At a hopping energetic party, for instance, two unacquainted single (reactive) people may, owing to necessary and sufficient sensory (photonic) stimuli (force), begin to spontaneously and uncontrollably glide towards each other, soon thereafter begin to date, and then spend the next fifty years happily skating through life as a fervent pair, all along the way wondering where the time went. Spontaneous human reactive processes are those such that physical and neurological attractions predominate over physical and neurological repulsions in the mental and physical state of the individual. Spontaneous chemical reactions occur because they are energetically favored.[27]

In the middle range, on the relationship scale, there exist ambivalent molecular relationships. Ambivalent relationships, marriages, friendships, or occupational engagements, etc., tend not to function well and do not usually work in the long run.[4] Unfavorable energetics are typically associated with destabilizing situations. Favorable energetics, on the contrary, are such that the bonding dynamics associated with those processes result because they are system stabilizing arrangements. Thus, in any and all human relationships, attraction and repulsion are intimately connected. In general, we tend to love things for which we are attracted to and to hate or despise things for which we deem as repulsive. Typically, however, simultaneous feelings of attraction and repulsion will coexist within the bond. In efforts to begin to quantify this attraction-repulsion balance, we will discuss several bonding scales.

Situational bond type scales

In any generalized human bonding scenario, such as in a marriage, a relationship, a friend, a job, an associate, a location, a task, an objective, etc., qualitative effects of attraction and repulsion can be studied and quantified energetically using the nine-point *situational bond type* SBT scale:

-4	-3	-2	-1	0	+1	+2	+3	+4
Hate with a Passion	Hate	Extremely Dislike	Don't Like	Ambivalent	Like	Like a Lot	Love	Love with a Passion

Exergonic bondings, i.e. work energy releasing bonds, tend to have positive SBT values, whereas endergonic bondings, i.e. work energy absorbing bonds, tend to have negative SBT values.

In this direction, people who say they are 'trying hard' (putting a large amount of energy into their relationship) to improve their relationship, are 33% less likely to be happy than as compared to people who say that they are putting 'some effort', i.e. an average amount of energy, into improving their relationship (bond).[29] Furthermore, most people don't stay in unhappy relationships (weak bonds), and people who exit unhappy relationships, end up in a happy relationship (strong bonds) with in three years—and 74% of this latter group confirm that their new relationship (bond) is significantly better.[30]

To provide some real-life SBT examples, in '04 Thims interviewed nine people, three men and six women, regarding experienced views of bonding situations such as: relationship break-ups, divorces, quitting jobs, etc., and asked them to describe their 'relationship', in each of those situations at the time of their separation, i.e. bond-breakage, according to the above scale.

The first woman interviewed had recently put in her two-week notice where she worked. She described her job 'relationship' as a -4 SBT. Specifically, she hated her job with a passion. A second women who was in the first week of declaring her intentions for divorce, after two years of marriage, described her relationship at the time as 0; or -1 to +1, loosely; meaning a mixture of 'don't like', 'like', and 'ambivalent'. She stated that things initially started out at a +3, i.e. 'love', but eventually the problems began to accumulate.

One man described his relationship to his father as a -4. He stated that his father left him when he was eight, leaving to start a second family without first legally divorcing his first wife. He stated that his father use to lock him and his siblings in their room until it was time to leave; he lied to them and from this person's viewpoint the father didn't take responsibility for either of the families he started. A third woman who was 'glowing' with pregnancy with her first child stated that she had a +4 SBT relationship with her husband. A second man was married to his first wife for 5-years, with whom he had one daughter. At the time of their divorce he

described their relationship as a -1 to 0. He is now happily married to a second wife, of 4-years, in a +3 SBT relationship, as he states, with one child, a boy, between them. Furthermore, he says that the relationship to his first wife has worsened to a -4; that is, he 'hates her with a passion'.

A fourth woman started a relationship with someone she 'liked', i.e. SBT = +1; but eventually she ended it, where, as she says: 'it just wasn't there'. At the time she broke it off, she stated that the relationship was at about a 0, i.e. 'ambivalent'. The pair still has dinner together once and a while, yet they are separated by a distance of space, i.e. a long-distance bond: he lives in Colorado and she lives in Illinois. A fifth woman described her two-year relationship as 'roller-coaster' ride. When they first met, she felt a +2 towards him. During the course of the relationship, she says that she experienced the whole range, i.e. -4 to +4, of SBT values at various times in their bond (relationship). During the last year before they broke it off, she stated that the three SBT numbers that most characterized the relationship were: +4, -4, and 0; in that order.

A third man stated that when he first met his girlfriend he felt a +1 towards her. After a 6-month relationship, however, they broke it off. It was very intense, he says: 'a mixture of -4 and +4 but no middle stuff'. They now kind of hang out once and a while with a feeling of about SBT = 0, i.e. it fizzled out into an ambivalent relationship. A sixth women, who is several months away from quitting her current job, to become a nurse after she graduates, says the relationship she feels to her present job is a -4, i.e. she 'hates it with a passion'.

In summary of these nine people, we notice the reoccurring pattern that SBTs of 0 or below seem to correlate with time-frames or windows of bond-breakage and that +1-range relationships may not be exceptionally fervent in the long run. Conversely, positive SBTs, i.e. those greater than +1, seem to correlate with stability. In addition, we discern the chemical reality that human bonding is an evolving process. Not all bonds were meant to hold, as is the case with all chemical bonds. Moreover, not all chemical reactions proceed at the same rate. Some reactions are hot and quick while others burn slow over longer time intervals. The rusting of iron, for example, is a slow combustion reaction, whereas the burning of wood, by comparison, is a fast combustion reaction; yet they both are exothermic combustion reactions.

A second type of bond-state scale used to quantitatively measure attraction and repulsion in human reaction life is the versatile sixty-one-point *attraction-to-repulsion scale*, having set values of: -30 (extremely repulsive) to 0 (ambivalent) to +30 (extremely attractive). This scale can also be used to measure the pulse of any relationship or bonding feature of a person. To use this scale, each of the mate qualities, physical and neurological, associated with a person are numerically quantified according to the perception of the bonded partner. These attraction-to-

repulsion (A-to-R) values can then be mathematically correlated to determine bond stability ratios.

In general, to review, total interpersonal attractiveness can be divided into two bonding categories, i.e. *neurological attractiveness attributes*, such as personality, occupation, intelligence, etc., and *physical attractiveness attributes*, such as health, size, symmetry, complexion, etc. In 2004, to highlight this point, Thims utilized the A-to-R scale to determine the average attraction-to-repulsion male perceptual values associated with breast size.[31] Specifically, Thims conducted a study involving 10 men and eight before-and-after breast augmentation photographs of four women aged 19 to 23, to determine levels of attraction and repulsion with respect to breast size, shape, symmetry, color, and overall visual appeal. The essential purpose of this study was to determine if 'repulsion' is a significant factor in mate selection. The majority of rating studies, for example, will use positive scales, e.g. the 1-7 Likert type scale or the hot-or-not 1-10 scale; yet this implies that the rated feature will always have some positive value of attraction. Such scales are not necessarily based on reality; accurate scales will always take into account repulsion, i.e. negative values, as a factor. Some, for instance, might naively assume that men will always be attracted to a pair of breasts.

This study was concerned specifically with female breast visual appeal, with focus on size, shape, symmetry, and skin tone. The interesting results of this study found that the 'before' photos had an average A-to-R value of -6.28, with a range of 2.8 to -15.4. Conversely, the 'after' photographs had an average A-to-R value of 21.0, with a range of 17.3 to 24.9. These results clearly indicate that certain visual human molecular features, such as breast size, can function to have a repulsive effect.[31] The similar case holds for phallus length, in which, although the average male length 6.2 inches, women, on average, are most attracted to a 6.7 inch length phallus, and most repulsed by lengths greater than 8.0 inches as well as those 5.0 inches or less.[32]

Attraction-to-repulsion ratios, as we will show, have a strong correction to reaction rate. Specifically, studies show that values of both neurological as well as physical attraction, on average, determine a person's reaction rate, i.e. how quickly they will reach equilibrium in a relationship or bonding objective. When a person or a couple is at equilibrium it means that no further change will occur, i.e. the bonds and the relationship both have stopped evolving. People with high levels of physical attractiveness, to note, tend to react more and to reach reaction equilibrium quicker in a relationship, i.e. divorce and remarriage is more common for highly-physically attractive people.[33] These relationship rate variations, as we will show, have a significant correlation to interpersonal bond composition.

Human reaction rate variations

In the course of human reaction life, over 95 percent of people will at one point bond to a special someone in the form of a marriage.[34] On this eventful day, the couple will typically exchange *wedding vows*, which are mutual agreements or a contract to stay intimately bonded throughout life. After repeating the wedding vows, the celebrant traditionally says to the groom, 'you may now kiss the bride':

Newly married couple after exchanging vows

Marriage vows, technically, are legal promises a couple makes to each other during a wedding ceremony. In Western cultures, these promises may often include the notions of affection, e.g. 'love, comfort, keep', faithfulness, e.g. 'forsaking all others', unconditionality, e.g. 'for richer or for poorer', or 'in sickness and in health', etc., and permanence, e.g. 'as long as we both shall live', or the ever-present 'until death do us part'.[35] The bulk of these statements, however, are incongruent with the laws and principles of chemistry. Namely, in nature, reaction rates vary.

In physical chemistry, reactions between molecular species do not continue until one of the reactants ceases to be, but rather until the reaction comes to equilibrium.[36] The branch of physical chemistry that studies the phenomena of reaction rates is called *chemical kinetics* and is concerned with the measuring and analysis of rates of chemical reactions under different conditions as well as their mechanisms.[37] The basic principles behind the study of chemical kinetics was pioneered by Norwegian chemist Peter Waage with his 1864 formulation of the *law of mass action*, which states that the speed of a chemical reaction is proportional to the quantity of the reacting substances.[38] Said another way, the law of mass action states:

> "The rate of a chemical reaction is directly proportional to the product of the effective concentrations of each participating molecule."

In human reaction terms, in olden days, for example, when human population concentrations were lower, people got married once and stayed married longer. In a small town, for example, reaction potentials or options will be limited; in this situation, optimal pairs will be drawn to each other quickly, in such a manner that further marriage reactions would be improbable. When effective concentrations begin to increase, however, such as in larger towns or when population counts rise, reaction rates will increase.

In the U.S., to give an idea of this effect, in 2002, population = 278 million human molecules, 59 percent of the population was married, which is down from 62 percent in 1990, population = 249 million, and 72 percent in 1970, population = 203 million.[39] Hence, higher concentrations, in modern times, have affected reaction rates and human reactions are becoming more diversified. In 2007, in the U.S., with a higher molecular species concentration, of about 300 million human molecules, divorce rates and the correlative or subsequent second or third marriage reactions that entail are on the rise. In other words, colloquially, when there's more fish in the sea, more people will go fishing. Thermodynamically, this correlates to the effect that there are more potentials available.[40]

To summarize, in human molecular relationships, if the vow 'till death do us part' is to be congruent with reality, specifically the laws inherent in the sciences of physical chemistry, chemical thermodynamics, and quantum mechanics, which regulate human life, it should correctly read 'till *relationship death* do us part'. In other words, from a dynamical point of view, relationship reactions will continue to evolve, through a process of what is called thermalization, until the relationship reaches a point called thermodynamic equilibrium. In evolution, thermodynamic equilibrium is equal to death (relationship death).[41]

In physics, *thermalization* is the process in which particles, atoms, or molecules reach thermal equilibrium, i.e. that state in which no energy flows; through mutual interaction.[42] As an example, when a molecule absorbs energy, as in the technique of molecular fluorescence, the lifetime of the excited state is in the neighborhood of 10^{12} sec. It then rapidly loses energy to the lowest level of the lowest excited state; this process is called thermalization. Similarly, the achievements of equilibrium in plasma as well as the process undergone by high-energy neutrons as they lose energy by collision are examples of thermalization.

These same energy use principles apply in human relationships. In evolving dynamic relationships, partners are stimulated and energized by each other. This energy is used as fuel for the drive in life. In some human reactions, this fuel will carry a pair continuously through their mutual life-span. In others, the tank will run out. In general, any heightened-state atom, molecule, human molecule, or bonded pair, etc., will rapidly lose energy to the lowest level of the lowest excited state; this process is called thermalization. The release of this energy, often used in an intuitively functional manner, will typically go towards external work. The rate of

this energy release or use, through interaction dynamics, subsequently, determines the 'lifetime' of the relationship.

In the U.S., to give an idea of *relationship lifetime*, 82 percent of married people will reach their 5th wedding anniversary, 65 percent will reach their 10th anniversary, 57 percent will reach their 15th anniversary, 33 percent will reach their 'silver' 25th wedding anniversary, and a lucky 5 percent will reach their 'golden' 50th wedding anniversary.[43] Less than five percent of people who marry, however, will ever reach the most-coveted diamond 60th, platinum 70th, or oak 80th wedding anniversaries.[44] In human chemical terms, in chemical kinetics a reaction *rate constant k* quantifies the speed of each chemical reaction. Reaction rate constants are determined experimentally and depend on the concentrations and 'activities' of the species.[37]

In sum, not all chemical reactions proceed at the same rate. This rule applies to human chemical reactions as well. Some are hot and quick like exploding dynamite, others slow and warm like a burning candle, and some never burn. A simple analogy, with reference to the variations in human reaction rates and of the heat released in typical human chemical reactions, is the amount of heat released in campfires, which varies per wood type. Wood burning is a *combustion reaction* in which hydrocarbon molecules react exothermally, i.e. give off heat, with oxygen molecules to produce the products of water and carbon dioxide.

Combustions reactions, although all involve the release of energy, come in many types including: *rapid*, i.e. those at high temperatures, often involving fire, *slow*, i.e. those at low temperature, e.g. respirations or rusting, *complete*, those in which all reactant is converted to product with no residuals, *turbulent*, those characterized by turbulent flows, e.g. gas turbines, diesel engines, etc., *incomplete*, those where not all reactant is combusted, e.g. due to a lack of oxygen or those quenched by a heat sink, e.g. a solid surface or flame trap, and *smoldering*, a flameless form of combustion, deriving its heat from heterogeneous reactions occurring on a surface of solid fuel when heated in an oxidizing environment. To exemplify this, the rapid combustion reaction for the methane molecule CH_4 is shown below:

$$CH_4 + 2O_2 \rightarrow CO_2 + H_2O + heat \qquad [6.4]$$

The reaction between two human molecules is approximately the same process, aside from the fact that human reactions occur over substrate, and that the *heat*, 'meaning energy in transit', released per human reaction is more complicated to explain, but predominately releases in the form of evolution or functional work as well as exchange, motion, and friction. To elaborate on this, a simple example is that of wood burning. Wood is essentially a big system of hydrocarbon molecules, similar to methane. As any seasoned camper will know, woods such as birch and maple will make big fires but will burn out sooner; conversely, woods such as pine and oak will continue to burn and provide fire for a much longer time span. The difference

between the two types of heating effects resides in the difference in the strength of the bonding of the hydrocarbon molecules in the wood.

In general, the heating potential of firewood per cubic meter or per log varies widely, depending upon the species of tree from which the wood is cut and thus the density of the log. In the United States, firewood is typically broadly classified into two categories: *hardwood* (broadleaf trees) and *softwood* (conifers). These labels are often misleading, as some species of conifer have harder wood than some species of broad-leaf tree. Generally, however, the harder the wood, a factor that results from slower growth, the denser it is and the greater the amount of biomass per unit volume. Such woods, when well-seasoned, produce hot, long-burning fires with relatively little particulate emissions. Varieties of wood such as oak, hard maple, hickory, and most of the fruit woods, e.g. apple, cherry, etc., have the hardest, most dense wood, and are most desirable for firewood. Broad-leafed varieties such as willow, aspen, or poplar have less-dense wood and require a greater volume of wood to produce the same amount of heat.[45] Here we see correlations between growth rates, bond strength, heat, volume, and reaction rate.

Likewise, variations in bond strengths in human relationships, A≡B, correlate directly with the duration or length of human chemical reactions, i.e. how long they will last, the intensity of heat given off, whether they will burn out or burn at all, etc. Humans have differing growth rates, which vary per unique level of physical hotness, i.e. some will sexually mature faster than others, as well as with nutritive intake, e.g. those who eat in excess will sexually mature faster. It is well-known, for example, that highly *physically-attractive* people tend to have their first sexual encounter at an earlier age, tend to react more often, require more personal space (volume) in crowds, tend to be more promiscuous, tend to have a larger number of sexual partners, tend to have higher divorce rates (weaker A≡B bonds), and tend to produce more product, i.e. children.[46] Studies of certain animal species with bi-parental care, for instance, show that high phenotypic quality males, i.e. physically attractive males, invest *less* in each female, i.e. they will leave sooner, than males of lower phenotypic quality.[47]

Male pine engraver beetles, for example, assist the female in creating tunnels for her brood and defend these nests from potential predators. Studies indicate, interestingly, that ‘large’ males leave the nest, i.e. debond and stop investing, sooner than smaller males.[48] To explain this pattern, zoologists note that larger, and therefore higher-quality males in terms of flying capabilities, had a greater potential for further reproduction than did smaller males. Larger males, therefore, benefit by leaving, i.e. debonding, earlier in terms of increased likelihood of achieving a greater number of mates. Conversely, smaller males have less reproductive potential and knowing intuitively that paternal care in brood investment is positively correlated to the relative success of the brood, once a small male mates, he tends to benefit by

staying with the female longer.[47] Thus, the length of bonding, i.e. reaction rate, or bond duration has a direct correlation with phenotypic quality.

Along these lines, it is known that highly *neurologically-attractive* people have quite different bonds to others as contrasted with the types of bonds utilized by highly *physically-attractive* people. Specifically, the relationship bonds of highly-physically attractive people tend to be more physical in composition, i.e. there is a strong visceral connection and a large amount of *physical heat* 'Q_P' involved, whereas the relationship bonds of highly neurologically attractive people tend to be more neurological in composition, i.e. there is a strong mental connection and a larger amount of *neurological heat* 'Q_N' involved. Generally, however, the 'hotter' (a factor that equates to the intensity of energy flow) each partner is, mutually and reciprocally, for each other, both physically and neurologically, the stronger the bond.

When polled, and asked to think about one's best intimate relationship in life, and to then characterize the composition of that bond, people, on average, tend to specify their bonds to be 44% physical in composition and 56% neurological in composition, i.e. a 44:56 ratio.[48] Those married for seven or more years tend to describe their bonds as being 40:60 in composition, physical-to-neurological. Highly attractive people, i.e. those scoring in the top ten to twenty percent of submitted photos at rating sites such as *hotornot.com*, tend to have bonds 90:10 in composition, being inherently hotter but weaker in strength, e.g. highly attractive people, as mentioned, tend to divorce or de-bond more often. Homecoming queens and beauty pageant winners, for example, tend to have 90:10 compositional pair-bonds, i.e. their best or most memorable romantic bonds tend to be primarily physical in compositional nature.[48]

Less physically attractive people, i.e. those persons scoring on the lower end of photographic rating sites, but higher on neurological attractiveness end of the scale, conversely, tend to have bonds 10:90 in composition, being stronger to a degree, e.g. less physically attractive couples, as mentioned, tend to divorce or de-bond less often. From these findings, noting that neurological adhesions tend to be of a stronger or denser variety than physical adhesions, it is reasonable to postulate that this characteristic may account for variations in human reaction rates. Namely, that bond compositions, physical-to-neurological, correlate to thermalization rates, which in turn have a second correlation to divorce rates.

In chemistry, all bonds will immediately terminate when a reaction becomes no longer energetically feasible. Energetic feasibility in isothermal, isobaric chemically reacting systems, i.e. earth systems, is determined by measures of changes in the Gibbs free energy ΔG, i.e. available chemical work energy, of the reacting system. When a human bonding dynamic can continue to release chemical work energy, in a functional manner, the reaction will continue, advance, or proceed. When a reaction terminates, a molecular divorce occurs. Chemically, as mentioned, the processes of

molecular divorce, breakups, decouplings, or de-bondings are called decomposition reactions or simply *disassociation* reactions, of the form shown below:

$$AB \rightarrow A + B \qquad [6.5]$$

In other words, when a relationship stops working, molecular species *A* slowly begins to detach or separate from molecular species *B* and continues in this direction until a bond no longer exists. In human reaction time, a divorce tends to take as long if not longer than the combination reaction.[50] In a typical uncoupling process, it is the *initiator*, i.e. the person who makes the initial recognition of unhappiness, who unconsciously signals the start of the de-bonding reaction, although the recognition of this moment can only be discerned in retrospect.[50]

In this direction, as many know, no human attachment is perfect and personal differences will arise in any relationship. In terms of bond composition, statistically, according to observations of videotaped recordings of hundreds of married couples, it is known that a reacting pair must have at least five times as many positive as negative moments together in their relationship (bond) if their marriage (reaction) is to be dynamically stable.[51] In the strict sense used here, *moments* are defined as instantaneous microsecond interpersonal exchanges. The sum of all moments define life. *Positive moments* are defined as: touching, smiling, complementing, laughing, joking-around, and passion, etc., and tend to effect spatial attractive movements. *Negative moments* are defined as: fighting, criticism, contempt, belittlement, yelling, screaming, degradation, defensiveness, withdrawal, loneliness, and isolation, etc., and tend to effect spatial repulsive movements.

In sum, the stability ratio of positive-to-negative interactions in any working relationship tends to be 5-to-1. Positive interactions mediate attraction, negative interactions mediate repulsion. Furthermore, married couples who eventually split-up show *slightly* more negative then positive acts.[51] In other words, once one starts to teeter a bit more to the left side of the SBT-scale, then a breakup is inevitable. This results because the repulsive forces in the relationship bond will begin to outweigh the attractive forces and separation will result.

The first to state that attraction-to-repulsion ratios have a function within active relationships was British chemist and physicist Humphry Davy, who, by the age of seventeen, had already begun to speculate on a dynamical theory of matter and motion. In 1796, Davy stated specifically that 'far from being conscious of the existence of matter, we are only conscious of the active powers of some being' and that 'by discovering the *ratio between the attractive and repulsion* of external things and our organs, we should discover philosophy.'[52]

In this direction, as a first approximation in efforts to correlate total SBT attraction-to-repulsion bonding values with chemical reaction thermodynamic quantities, we will tentatively set the following equivalences:

SBT > 0 correlate with $\Delta G < 0$ (a spontaneous favored reaction)
SBT = 0 correlate with $\Delta G = 0$ (a reaction at equilibrium)
SBT < 0 correlate with $\Delta G > 0$ (an un-favored reaction)

In all reactions, to note, the magnitude of $|\Delta G|$ is proportional to the degree or force of the spontaneity. A calculated ΔG value of -100 energy units, the negative sign indicating available energy release going out of the system, for example, would be indicative of a reaction with greater potential spontaneity than as compared to a reaction with a ΔG value of -10 energy units. Therefore, a 'like' reaction potential, for instance, may be slightly spontaneous, whereas a 'love with a passion' potential would be extremely spontaneous. In general, the magnitude of $|\Delta G|$ correlates to the *naturalness* of the process.

To clarify further, let us go through the real-life example case of the man *Mx*, discussed above, who in his first reaction had one child Bc_1 with his first wife Fy_1:

$$Mx + Fy_1 \rightarrow MxFy_1 \rightarrow MxFy_1Bc_1 \qquad [6.6]$$

Later, following five years of marriage, after the state of the relationship had reached a SBT = -0.5, i.e. 'don't like' to 'ambivalent', they got a divorce, after which the child remained with the mother:

$$MxFy_1Bc_1 \rightarrow Mx + Fy_1Bc_1 \qquad [6.7]$$

Presently, the man is happily married, SBT = +3, i.e. in 'love', with his second wife Fy_2, of 4-years, having reacted to produce one child Bc_2 between them:

$$Mx + Fy_2 \rightarrow MxFy_2Bc_2 \qquad [6.8]$$

Each of these reactions happened, as we see, spontaneously. Each reaction, thus, correlates to a negative Gibbs free energy change in the reacting system: $\Delta G < 0$, as is the case with all spontaneous chemical reactions, meaning that, for each reaction, energy in the form of productive or usable work was released out of the relationship. Conversely, when the first couple $MxFy_1$ got a divorce, the energetic state of their relationship would have been quantified by either $\Delta G = 0$, i.e. equilibrium, or $\Delta G > 0$, i.e. not-working.

A factor to note here, as discussed, is that there is an associated effect called *exergonic-endergonic coupling* in which relatively weak reactions will couple to strong reactions. In other words, secondary and tertiary reactions, e.g. friend, family, or social views, etc., and the bond connections therein, will effect the free energy

calculations of the couple. In social terms, nepotism, in which weaker reactions of individuals can thrive off the strength of others, is an example.

Likewise, in some cases, strong family peer pressure can drive a less-favored marriage reaction forward. The 2001 comedy film *Legally Blonde*, based on the novel of the same name by Amanda Brown, gives one example of this.[53] In the movie, Harvard Law School-bound Warner Huntington III (Matthew Davis) is 'forced' to break up with highly (physically) attractive, pampered, west coast, Barbie-doll blonde (less neurologically attractive), homecoming queen, Cosmo girl Elle Woods (Reese Witherspoon), who was Miss June on the school calendar, so to instead marry the less (physically) attractive but more respectable (more neurologically attractive), east coast, country club, brunette, socialite, law student Vivian Kensington (Selma Blair), because, as he says, 'you have no idea of the *pressure* I'm under, my family has five generations of senators, my brother is in the top three at Yale law, and he just got engaged to a Vanderbilt for Christ's sake.' This is an example of a human chemical reaction influenced or rather driven in certain life directions by external driving forces, i.e. free energy coupling effects.

Conversely, in other situations, such as generational family peer pressure, free energy coupling effects can intensely drive a person to achieve greatness. It is frequently pointed out, for example, that in Willard Gibbs' heritage, thirteen of his direct ancestors, in the six previous generations, were college graduates, eight of Harvard, three of Yale, and two of Princeton.[54] These coupling pressures may have driven Gibbs to script, what Gilbert Lewis and Merle Randall have called, the 'great manuscript', namely 'On the Equilibrium of Heterogeneous Substances'. To explain these generational driving forces thermodynamically, we note that free energy, which is a function of the universal enthalpic and entropy driving forces, is an extensive quantity, meaning that the free energies can add up.

An *extensive quantity*, or extensity, is a quantity proportional to the dimension of the system. The dimension may be length, a surface, or most often a volume, an amount of electricity, an amount of substance, an entropy, and the state functions *U, H, F, G,* etc.[55] A corollary theorem for these quantities is that for a reversible transformation, the extensity is conservative. If two systems *A* and *B*, which are considered to be isolated by social barriers, such as two connected generations in a close knit family, are at equilibrium or evolving towards equilibrium, the two systems will exchange extensity. The change in the Gibbs free energy in this coupled-type situation for the whole system is:

$$dG = dG_A + dG_B \qquad [6.9]$$

At equilibrium, extensity gained by *A* is lost by *B*, and conversely.[55] In short, the free energy released from one generation can drive the reactions in a second or third generation. In this manner, along the lines of equations [2.2], [5.4], and [5.5], the Gibbs

free energy change for a seven generation reaction, using the life of Willard Gibbs, i.e. ΔG_7, as an example, this can be written as:

$$\Delta G_{total} = \Delta G_1 + \Delta G_2 + \Delta G_3 + \Delta G_4 + \Delta G_5 + \Delta G_6 + \Delta G_7 \qquad [6.10]$$

In other words, the course and severity of Willard Gibbs strict educational life may not have been able to go on its own, i.e. $\Delta G_7 > 0$, but if this reaction were coupled to the extensities released from generations one through six, the total process will work, i.e. $\Delta G_{total} < 0$. The assumption of families being thermodynamically isolated, however, is an approximation; in a more advanced analysis, the extensity exchanged in side reactions would need to be accounted for as well.

As we see, these thermodynamic applications are eye-opening and enjoyable. A point that will be difficult to assimilate, however, will be the idea that we regard it as a known fact that small molecules, e.g. molecules in combustion reactions, do not have any choice in their reaction, whereas human molecules in chemical reactions do have a choice. These two perspectives, inevitably, contradict each other—a bit of a paradox we might think. This was a central issue in Goethe's affinities. As we will find, education will be the key to the resolution of this crux. In 1929, for example, to elaborate on this point further, Albert Einstein once famously stated:

> "Everything is determined … by forces over which we have no control. It is determined for the insect as well as the star. Human beings, vegetables, or cosmic dust—we all dance to a mysterious tune, intoned in the distance by an invisible piper."

The good way to clarify this confusion is to use two perspectives: one in terms of viewing 'life' from *inside the molecule* (i.e. one's life), and one in terms of viewing 'life' from *outside the molecule* (i.e. atomic life). Each molecule obviously adheres to the same laws, only the prior is our perspective of daily life and will inherently 'feel' more sensible. Since, ultimately, as it appears that we are under the control of 'forces' it would then be in our best interest to understand their operation with regard to human life.

To elaborate further on the historical underpinnings associated with the elusive word force, we will refer to the classic 1957 book *Concepts of Force* by Israeli physicist Max Jammer, a close colleague of Albert Einstein at Princton.[56] In his book, Jammer traces the development of the concept of force from antiquity to modernity.[57] After reviewing all of the various historical theories of force, most of which deriving from Newton's 1686 *Principia*, Jammer elegantly shows how all

conceptions of force, past and present, boil down essentially to a function of system configuration.

In other words, according to Jammer, 'the concept of force in contemporary physics plays the role of a methodological intermediate comparable to the so-called middle term in the traditional syllogism.' In order to show, for instance, that 'Socrates is mortal', we introduce the middle term 'man' and state the two premises: (1) All men are mortal; (2) Socrates is a man. In the final result, 'Socrates is mortal', the middle term 'man' drops out. Likewise, according to Jammer, 'to show or predict that a certain body *A* moves on a certain trajectory *B,* when surrounded by a given constellation of bodies *C, D, ...,* which may be gravitating, electrically charged, magnetized, and so forth, we introduce the middle term 'force' and state the two premises: (1) The constellation *C, D, ...* gives rise to a force *F*; (2) the force *F*, according to the laws of motion, makes the body *A* move on the trajectory *B*. In our final conclusion, 'Body *A*, surrounded by *C, D, ...* under the given circumstances, moves along trajectory *B*,' the middle term 'force' again drops out.'

In the human scenario, the same result applies. In the constellation of persons *C, D,* and *E,* for example, we can say that the configuration of the situation gives rise to a force *F*, which causes person *A*, under the give circumstances, to move along trajectory *B*. Likewise, the same situation can be stated such that when person *A* is surrounded by persons *C, D,* and *E*, the circumstance will cause person *A* to move along trajectory *B*, whereby, again, the middle term 'force' drops out.

Mathematically, within the framework of classical mechanics, which are those situations of non-relativistic velocities, experience shows that the product of the inertial mass *m* of a test body *A* and its acceleration *a*, or *ma*, is a function Φ (phi) of the total configuration under discussion:

$$ma = \Phi(X) \qquad [6.11]$$

The symbol *X* denotes the configuration under discussion. The term 'configuration' here, according to Jammer, refers to the amounts of gravitational masses, electric charges, magnetic moments, and so forth, as well as geometric constellations involved, in relation to the set of bodies in the system.

Thus, for example, it is relatively easy to explain Newton's laws of motion from this perspective. Newton's *second law* states that there exists a definite relationship between an object's mass *m*, its acceleration *a*, and the applied force *F* according to the equation $F = ma$. Hence, according to [6.11], this law is an empirical statement with respect to the fact the product of 'mass times acceleration' is a single-valued function of the configuration *X* of the system.

Likewise, if we postulate that the product *ma*, being a function of *X*, vanishes at infinity, i.e. if the function Φ tends to zero as the distance variables in its argument increase indefinitely, we arrive at the law of inertia, or Newton's *first law*, which

states that every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed upon it. Newton's first law may thus be conceived as a boundary condition of the function Φ.[57]

Newton's *third law* states that all forces occur in pairs, and these two forces are equal in magnitude and opposite in direction. This is often paraphrased as for every action there is an equal and opposite reaction. In terms of [6.11], if a system A, with a configuration X_1, acts on a second system B, with a configuration X_2, the effect of the change in configuration X_2 will be equal and opposite to that of the change in the configuration of system X_1.

Lastly, the classical treatment of the gravitational two-body problem results such that if we let m be the mass of one body and M that of another body and r be the distance between the two, the function Φ is then given by the expression:

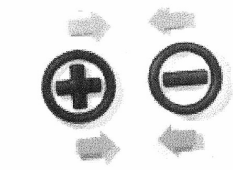
$$\Phi = G\frac{mM}{r^2} \qquad [6.12]$$

This equation is known as Newton's *law of universal gravitation*, where G is the gravitational constant. In sum, according to [6.11], the basic laws of motion are functions of configuration X.[57] Configurations in the earth system, e.g. systems of interactive human molecules, refer to arrangements of nuclei, electrons, and photons.

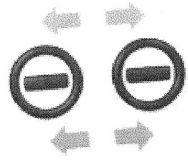
Nuclei, electrons, and photons

In colloquial terms, regarding human attachments, the force associated with the two powerful effects of love and hate, or attraction and repulsion, tend to overlap and intertwine in such a manner to create a bonding effect. In the preceding chapters, we outlined the supposition that human beings are molecular structures. Along these lines, as it is currently understood, all molecular structures in the universe evolved from collections of interactive hydrogen and helium atoms, an evolution process that began shortly after the inception of the universe, 13.7 billion years ago.[58] As such, the reactionary tendencies of these atomic evolutionary processes are still embedded within the construct of the human organism.

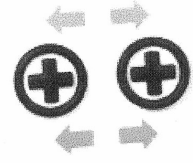
In general, molecular structures hold together owing to a balance of attraction to repulsion. The structure of atoms and molecules, which configure to form molecular structures, are made of positively charged nuclei and negatively changed clouds of electrons. Positive and negative charges attract, whereas like charges repel:



Opposite Charges Attract



Like Charges Repel



Like Charges Repel

This description, although we are greatly oversimplifying many details, is the basis of all molecular interactions. Specifically, electrons move in such a manner so as to create shapes of negatively charged clouds in the form of circles, dumbbells, donuts, and more exotic configurations.[59] The negatively-charged clouds, in general, move in such a manner so to 'attract' towards the positively charged nuclei. Only so many negatively charged clouds, however, can fit around a single positively charged nucleus. This creates a *crowding effect* in which adjacent clouds 'repel' each other. The quantum field particles that mediate the dynamics of this process, as discussed further in chapter eight, are called photons.

Attraction forces counterbalanced by repulsive forces are an ever-present feature of the universe. Within stars, gravitational attraction is balanced by thermonuclear repulsion; in atoms, as described above, electromagnetic attraction is balanced by Coulombic repulsion; in nucleons, quarks are strongly affixed together owing to gluonic attraction balanced by gluonic repulsion. The technical or theoretical details to many of these processes, to note, such as that of gravitational stability, are in need of further analysis. Yet, the overall trend is clear: repulsion tendencies function or actuate to stabilize attraction tendencies, in such a manner, so as to create various spatial-temporal bonding configurations, e.g. the human pair bond.

History of attraction and repulsion theories

Modern quantum theory helps to clarify our understanding of chemical bonding in terms of electromagnetic attractions and repulsions. Attraction and repulsion theories, however, have been long in development. Throughout history, people have often considered phenomena such as 'love at first sight' or 'instant friendships' to be the result of an uncontrollable force of attraction or affinity. One of the first to theorize in this direction was the Greek philosopher Empedocles who in the fourth century BC argued for existence of two forces: love (*philia*) and strife (*neikos*), which were used to account for the causes of motion in the universe. These two forces were said to intermingle with the four elements, i.e. earth, water, air, and fire, in such a manner that love, so to say, served as the binding power linking the various parts of existence harmoniously together.

Later, Plato interpreted Empedocles' two agents as *attraction* and *repulsion*, stating that their operation is conceived in an alternate sequence.[57] From these arguments, Plato originated the concept of 'likes attract', e.g. earth is thus attracted towards earth, water toward water, and fire toward fire. In modern terms this is often phrased in terms of 'birds of a feather flock together'. In the 18th century, this came to be known as the *first law of affinity* and presently it is known as one of the eponymous 'laws of attraction', that relationship theorizers expound on so much.

In the thirteenth century, the problem of the motion of heavy bodies engaged many writers. Bonaventure, a Franciscan physician, for example, explained the

cause of the motion of a heavy body by a hypothetical 'force of repulsion' exerted on it by the celestial spheres. He reasoned that the cause of the production of gravity or 'grave', from the Latin *gravis*, meaning heavy, was the result of the removal of the impregnations of portions of matter of *forma terrae* in such a manner that a repulsive force was initiated. In this manner, according to Bonaventure, repulsion attenuates with distance.[60]

In the sixteenth century, English physicist William Gilbert conducted the first systematic scientific experiments on electrical phenomena. He published the results of his findings in the 1600 treatise *De magnete*. In this great work he theorized on the nature of compass attraction towards the North Pole and elaborated on the effects of static electricity using amber. Amber, which possesses the property of attracting light objects when rubbed, is called *elektron* in Greek; hence Gilbert decided to call its effect the 'electric force'. The term 'electricity', according to Gilbert, is applied to denote the physical agency which exhibits itself by effects of attraction and repulsion when particular substances are rubbed or heated, also in certain chemical and physiological actions and in connection with moving magnets and metallic circuits. Similarly, in 1675, Robert Boyle noted that electric attraction and repulsion can act across a vacuum.

In 1735, Dutch chemist and physician Herman Boerhaave articulated the logic that 'heat' is an integral part of any chemical composition and viewed the constitution of bodies as 'an equilibrium' of attractive and repulsive forces. In human reaction terms, two humans attached in the form of an evolving, thermalizing, dihumanide molecule, e.g. a romantically bonded pair *MxFy* or two close friends *AB*, as mentioned, tend to be separated by no more than two points in physical heat. Moreover, stable human relationships, i.e. SBT > 1, tend to exist in a dynamic *flow state* evolving towards true equilibrium.

In 1746, an electrical energy storage device called the Leyden jar (capacitor) was discovered by Pieter van Musschenbroek at Leiden University. The following year, it was discovered that a discharge of static electricity was equivalent to an electric current. Later, following further developments in electrical theories, such as Coulomb's law, which showed that positive and negative charges attract, analogs in human relationship life were developed such as 'opposites attract'.

Coulomb's law, in particular, is an electromagnetic mathematical relation proposed in 1785 by the French physicist Charles Coulomb, presented in three reports on electricity and magnetism. In these, Coulomb determined experimentally the law that explains how two bodies electrified of the same kind of electricity exert forces on each other and how the determination according to which laws of both the magnetic and the electric fluids act either by repulsion or by attraction. Coulomb explained the laws of attraction and repulsion between electric charges and magnetic poles, although he did not find any relationship between the two phenomena. He thought that attraction and repulsion were due to different kinds of fluids.[61]

In 1787, French chemist Antoine Lavoisier published his famous *Elements of Chemistry*, in which he outlined one of the most accurate and logical attraction-to-repulsion theories to date. On the opening page, Lavoisier states that long ago Dutch physician and physical chemist Herman Boerhaave, in his 1724 *Elementa Chemiae*, established, as a physical axiom of nature, that 'every body, whether solid or fluid, is augmented in all its dimensions by any increase of its sensible heat.' By way of this axiom, according to Lavoisier, it is easy to conceive that the separation of the particles of a body by heat is a *general law of nature*, in which heated particles tend to separate from each other and cooled particles tend to approach each other.

Lavoisier goes on to state that, except at the degree of absolute cold, i.e. the depravation of all heat, the particles of a body do not touch each other, but rather are continually impelled by heat to separate from each other. To counteract this effect of separation, particles are held together 'by some power which tends to unite them, and so to speak, to chain them together, which power, whatever be its cause, or manner of operation, we name *attraction*'. According to this logic, Lavoisier states:

> "The particles of all bodies may be considered as subjected to the action of two opposite powers, the one *repulsive*, the other *attractive*, between which they remain in equilibrio."

Subsequently, 'so long as the attractive force remains stronger, the body must continue in a state of solidity.' This is an exceptional statement. As we will discuss shortly, this fundamental bonding principle was recently confirmed, in laboratory experiments, to be an accurate model for the compositional structure of all human bonds, particularly the marriage bond.[51]

Hence, knowing that, through external heating effects, solids can be made liquid, and liquids made vapor, Lavoisier reasoned that heat has, in some way, the power to remove the particles of a body from each other, so as to place them beyond their 'sphere of attraction', because of which they lose the adhesion they before had with each other, and the body ceases to be solid. Interestingly, as will be discussed in chapters eight and nine, humans have spheres of attraction and repulsion. Thus, according to Lavoisier, all bodies in nature are held in their states 'according to the *proportion* which takes place between the attractive force inherent in their particles, and the repulsive power of the heat acting upon them.' In other words, stable ratios of attraction-to-repulsion powers or forces hold entities together.

To explain this action of repulsion between particles, that can cause solid bodies to liquefy or become aeriform, Lavoisier conceived the idea that the sensation of heat or warmth in bodies is caused by a substance called 'caloric' that accumulates in the interstices between the particles, whereby the amount of caloric, between the

particles, correlates to the power of the repulsive action. To elaborate on what this caloric might be, Lavoisier declares that 'in the present state of knowledge, we are unable to determine whether light be a modification of caloric, or if caloric be, on the contrary, a modification of light.'

Lavoisier's caloric adhesion-repulsion theory is essentially correct. The basic difference between his version and modern chemical bonding theory is that Lavoisier used the conception of the 'caloric' particles, whereas in modern terms we use the notion of 'photon' particles, both of which being the cause of repulsion. The modern theory, of course, is more advanced, being structured on the mathematical details of quantum electrodynamics, but the essence of both theories is the same. According to Lavoisier, 'caloric communicates the power of repulsion to the particles of bodies'; in modern terms the photon (energy quantum) communicates the power of repulsion, as well as attraction, to the charged particles of bodies.

In 1812, building on the electric fluid conceptions of Coulomb, Siméon-Denis Poisson, a mathematics professor at École Polytechnique, propound new laws of electrostatics in which he theorized that electricity is made up of two fluids in which unlike elements attract and like elements repel. In the years to follow a mixture of electrical and molecular attraction and repulsion theories began to appear.

In 1869, building on this historical framework of those as Kepler, Newton, and Leibniz, and others, Harvard-trained American physician Charles Winslow published his 500-page *Force and Nature: Attraction and Repulsion – the Radical Principles of Energy, discussed in their Relations to Physical and Morphological Development*. In this fascinating compendium, in which the various historical theories of attraction and repulsion are elaborated on, Winslow points out the absurdity in neglecting molecular attraction and repulsion theories in science.

To hypothesize how the universe came to be, he states 'in the pre-universe time, either matter existed in the state of molecules endowed as definite chemical elements, crude, chaotic, and concentrated in a single mass, which, bursting in consequence of the *repulsive force*, scattering its fragments through space; or, that matter existed in the state of molecules universally diffused, as imagined by Sir William Herschel and Laplace, which condensed in consequence of the *attractive force*.' To note, these fascinating statements were made over sixty years prior to Belgian Roman Catholic priest Georges Lemaître's 1927 Big Bang theory, which proposed, on the basis of the recession of spiral nebulae, that the universe began as a simple 'primeval atom' which then exploded.

Next, in Winslow's chapter on molecules, after stating that the Greeks were the first to develop molecular attraction and repulsion theories, Winslow boldly declares that 'any system of physics which ignores the *capacities for reaction in molecules* – or the forces of, or central life, so to speak, in molecules, in any of their combinations or massive conditions, whether they be in motion or at rest – might be excused for inexactness were this the dawn of discovery, and an age of mere

speculative inquire; but when successive new revelations have overthrown ancient ideas, and science has assumed solidity and precision, it becomes unpardonable error in any physicist to cling to false hypotheses, even if no reasonable substitute be presented instead.' According to Winslow, 'we know that molecules exist … this is our first solid starting-point and stepping stone.' Likewise, herein, to update this statement, 'we know that human molecules exist … this is our first solid starting-point and stepping stone.'

In this direction, 'atoms', in Winslow's view, 'never lose their individuality nor their capacity to embrace and identify themselves with force, and to follow the movements of its currents and affinities as if they were not alone vehicles loaded with force, but as if they were identical with force itself.' The modern day take on this visualization is described remarkably well using American psychologist Mihaly Csikszentmihalyi's 1990 *flow theory*, in which optimal individuals, i.e. human molecules, are able to tap into innate pockets or currents of mental flow states, such that optimal life experience results. In positive psychology, *flow* is a mental state of operation in which the person is fully immersed in what he or she is doing, characterized by a feeling of energized focus, full involvement, and success in the process of the activity, as if they were identical with the force itself.[62]

To summarize these amazingly accurate view points for such an early year in the history of scientific thought, Winslow postulates that the repulsive force is the antagonist of attraction. In addition, according to Winslow, these two intimate forces function according to 'an electronic or thermal principle'. Moreover, 'the mutual attraction to unite or adhere to each other is called *attraction*; this principle of attraction is found to exist in all molecules.' Winslow reasons, since the attractive force is ubiquitous in all molecules, that 'it persists in exerting such a force upon other molecules, in virtue a secret influence found within the bosom of the molecule, which proceeds out of its own natural capacity and endowment.' Fascinatingly, Winslow goes on to state that 'while the force of attraction exists, and every atom mutually attracts every other atom, it is proven with equal certainty that molecules never touch each other, and that they are kept asunder by another force, the opposite of attraction; this is called *repulsion.*' Likewise, as will be shown in the chapters to follow, human molecules do not necessarily need to have physical contact to bond, but rather only patterned physical proximity and recurrent stabilizing exchange. Moreover, even during the most intimate of sexual contacts, humans do not touch, but rather are separated by a contiguous layer of photon-electron interaction found at the interstices of the atomic edge of the integumentary system.

To make a connection between Winslow's molecular principles and human life, namely interactions of reactive human molecules, regarding the interpersonal forces of attraction and repulsion, from his chapter on *Union and Inseparability of Matter and Force,* he states:

> Our discussion of molecules and of attraction and repulsion has presented them as distinct, separate, and positive entities, the existence of which, as the working material and dynamical powers of nature, lies at the bottom of all things ... it is desirable to receive these facts so deeply and clearly into the mind, that they may never be lost sight of in our future study of their diversified *relations*, *combinations*, and *reactions*.

All of science, according to Winslow, is built on these diversified reactions. Moreover, any branch of physical research that neglects the value of either of these elements must, according to Winslow, be 'more or less imperfect'. To encapsulate his argument, Winslow declares that 'countless researches and experiments of chemists and physicists have established beyond question the universal fact that repulsion is an absolute force, dwelling in all molecules, which exerts as constant and mutual an influence from one upon the other as does that of attraction. It dwells and lives within the molecule, and proceeds out of it, in like manner as attraction, to act upon its neighbor, except that it acts and plays in an opposite direction to the latter force.'[63] These exemplary theories, as we see, are some of the most accurate perspectives every enunciated on the intricate subject of molecular attraction and repulsion. Explaining these effects quantum electromagnetically, of course, is a more involved and advanced process; the same basic framework, however, is utilized with the additional quantum electrodynamic incorporation of an outer-shell electron-photon interaction perspective, conjoined with a psychological perspective.

Over the last century, researchers on the nature of human mating, such as in evolutionary psychology, agree that pairs unite or attract to each other owing to a combination of opposites attract, e.g. people with dissimilar immune systems tend to attract, and likes attract, such as similarities of personality, character, views, etc.[64] In recent years, various human bonding theories have been developed described in terms of attachments, ties, bonds, and or affinities, in which attraction and repulsion characteristics are interwoven and accounted for via psychology terminologies and conceptions of spatial proximity.

Mate desirability factors

The virtues connected with attraction and repulsion characteristics and tendencies are easily discernable in nearly every facet of human quality. Over the last fifty years, researchers have begun to catalog mate desirability traits from both a male and female point of view. Anthropologist Clellan Ford and psychologist Frank Beach, with their 1951 book *Patterns of Sexual Behavior*, were the first major researchers in

this area. By studying human mating patterns, cross-culturally, Ford and Beach were able to discern attractive and repulsive mate traits unique to each culture. The Kwakiutl, Lenge, and Tongans, for example, prefer small ankles in women, whereas the Ila, Maori, and Wogeo prefer shapely and fleshy calves. The converse physical features, for each respective culture, are deemed as repulsive.

In 1973, psychologist H. G. Gough developed a 76-item mate attribute list in order to study and represent a broad array of desirable attributes in potential mates.[65] Examples are adaptability, ability to plan, having an affectionate nature, having a dominant personality type, frugality, good cook, intelligent, loyal, neat, clean, physically attractive, tall, wealthy, and witty, etc. Included were characteristics representing social, physical, personal, goal, and background attributes of potential mates. Building on this outline, in 1986 American evolutionary psychologists David Buss and Michael Barnes published similar results in their 'Preferences in Human Mate Selection' article, in which they examined preferences in mate choice within the broader context of basic human mating systems.[66]

In 2003, using a similar type of mate desirability listing, Serbian psychologists Bojan Todosijevic, Snezana Ljubinkovic, and Aleksandra Arancic surveyed 127 college students at the Open University, Subotica, Serbia to determine the degree of desirability (attraction) or un-desirability (repulsion) of sixty behavioral and personal traits in a potential mate.[67] For their study, the seven-point Likert type scale was utilized, in which 1 = completely un-desirable and 7 = most desirable.[68] The results of this study are shown in the following table, in which a combined score, a male-perspective (Mx) score, and a female-perspective (Fy) score are listed. Numbers bolded indicated a marked difference in male-female perception.

The I (initial) and F (final) columns, are the levels of attraction or repulsion felt in a bond in regard to the indicated trait, noted by a woman, who was interviewed by Thims in '06 in relation to her ex-husband to whom she was married to for three years. The pair had one child together. Letters shown are perceptual values of either attraction *A* or repulsion *R* felt both at the *initial* stage (I) of their marriage and at the *final* stage (F) of their relationship when they split. The interview was conducted about 2-3 years after the divorce. The G{H,S} column, i.e. the human molecular Gibbs free energy as a function enthalpy *H* and entropy *S*, shows the approximate representative thermodynamic quantifiers as per the dodecabond model, as discussed in chapters nine and thirteen:

#	Trait	Both	Mx	Fy	I	F	G{H,S}
1	Sincerity	6.34	6.08	**6.53**	A	A	S_P, S_N
2	Faithfulness	6.29	6.23	6.32	A	A	S_P, S_N
3	Tenderness	5.90	5.98	5.84	A	R	S_P, S_N
4	Reliability	5.79	5.79	5.78	A	R	S_P, S_N
5	Communicative	5.79	5.83	5.77	A	R	S_P, S_I, S_N
6	Passion	5.79	5.87	5.74	A	R	S_P, S_O, S_I, S_N
7	Carefulness	5.78	5.80	5.77	A	R	S_P, S_N
8	Amusing	5.70	5.71	5.69	A	R	S_P
9	Love For Children	5.68	5.77	5.62	–	A	S_N
10	Self-Confidence	5.66	5.48	**5.78**	A	R	S_P, S_O, S_I, S_S, S_N
11	Maturity	5.60	5.44	**5.70**	–	R	S_P, S_O, S_I, S_S, S_N
12	Intelligence	5.52	5.38	**5.62**	A	R	S_I
13	Kindness	5.52	5.60	5.46	A	A	S_N
14	Tidiness	5.51	5.50	5.51	A	R	S_P, S_O, S_I
15	Ability	5.48	5.42	5.53	R	R	S_P, S_O, S_I, S_N
16	Sociability	5.46	5.54	5.41	A	A	S_P, S_S, S_N
17	Optimism	5.42	5.52	5.35	A	A	S_N
18	Sense Of Humor	5.40	5.35	5.43	R	R	S_P
19	Good Manners	5.34	5.26	5.39	A	R	S_P
20	Diligence	5.32	5.33	5.31	?	R	S_P, S_N
21	Capability To Earn	5.31	5.08	**5.47**	A	A	S_O, S_I
22	Physical Attractiveness	5.29	**5.50**	5.14	A	R	H_{AVG}, H_{AGE}, H_S, H_X, H_L, H_F, H_C
23	Independence	5.28	4.92	**5.53**	A	R	S_P, S_O, S_I, S_S
24	Erudition	5.20	4.98	**5.35**	?	R	S_I
25	Enterprising	5.19	4.92	**5.36**	–	R	S_O, S_I, S_N
26	Beauty	5.19	**5.60**	4.92	A	R	H_{AVG}, H_{AGE}, H_S, H_X, H_L, H_F, H_C
27	Ambition	5.17	5.02	**5.28**	A	A	S_N
28	Youth	5.10	5.00	5.16	–	R	H_{AGE}
29	Success In Job	5.06	5.06	5.07	–	A	S_O
30	Good Taste In Clothes	5.06	**5.29**	4.98	R	R	S_P, S_O, S_I, S_S
31	Courage	5.02	4.98	5.05	–	R	H_{AGE}, H_X, H_F, S_P, S_S, S_N
32	Good Looks	5.02	**5.34**	4.81	A	R	H_{AVG}, H_{AGE}, H_S, H_X, H_L, H_F, H_C
33	Elegance	4.93	**5.08**	4.82	R	R	S_P, S_O, S_I, S_S, S_N
34	Attractiveness	4.82	**5.12**	4.61	A	R	H_{AVG}, H_{AGE}, H_S, H_X, H_L, H_F, H_C
35	Seriousness	4.75	4.40	**4.99**	A	R	S_P, S_N
36	Temperament	4.70	**4.92**	4.54	R	A	S_P, S_N
37	Talkativeness	4.66	4.69	4.64	?	R	S_P, S_I
38	Thinness	4.17	**4.87**	3.69	R	A	H_{AVG}, H_{AGE}, H_X, H_L, H_F
39	Talent For Sports	4.09	4.00	4.15	A	A	H_{AVG}, H_X, H_F, S_O, S_I, S_S, S_N
40	Strength	3.95	3.42	**4.32**	?	R	H_{AVG}, H_{AGE}, H_S, H_X, H_L, H_F
41	Thriftiness	3.94	**4.22**	3.76	R	R	S_O, S_I
42	Dominance	3.90	3.92	3.89	R	R	S_P, S_O, S_I, S_S, S_N
43	To Have Money	3.88	3.82	3.92	R	R	S_O
44	Interesting Profession	3.73	3.84	3.65	R	R	S_O
45	Popularity	3.64	**3.87**	3.49	R	R	S_S
46	To Have A Car	3.64	3.54	3.70	R	R	S_O
47	Popularity Among Peers	3.52	**3.70**	3.41	R	A	S_P, S_S, S_N
48	Talent For Arts	3.48	3.50	3.46	R	R	S_O, S_I
49	Jealousy	2.79	**2.90**	2.70	R	R	S_P, S_N

50	Fragility	2.62	**3.04**	2.36	R	R	H_{AGE}, H_S, H_X, H_L, H_F, H_C
51	Shyness	2.61	**2.84**	2.46	R	R	S_P
52	Overweight	2.53	2.31	**2.69**	R	R	H_{AVG}, H_{AGE}, H_X, H_L, H_F, H_C
53	Introversion	2.18	2.29	2.11	R	R	S_P
54	Spoilt Brat	2.13	**2.25**	2.05	–	–	S_P
55	Self-Pity	2.02	**2.56**	1.65	–	–	S_P, S_N
56	Aggressiveness	1.99	**2.73**	1.49	–	A	H_X, H_F, S_P, S_N
57	Fearfulness	1.89	**2.29**	1.61	–	A	H_{AGE}, H_X, H_F, S_P, S_S, S_N
58	Insecurity	1.75	**1.92**	1.62	R	R	S_{TOTAL}, H_{TOTAL}
59	Selfishness	1.70	**1.94**	1.54	R	R	S_P, S_N
60	Conceitedness	1.56	**1.75**	1.42	?	R	S_P, S_N

Values with a dash '–' were used if there was uncertainty on how that particular trait in the bond was perceived; question marks '?' were used if, for some reason, there was confusion in regards to the indicated trait. Thus, neglecting those traits for which there was either uncertainty or confusion, 15 in total, we have 45 traits in which values of attraction or repulsion changed dramatically in the bonded relationship over the course of its reaction.

Specifically, of these, at the start of the reaction (relationship) 55% of those traits were viewed as 'attractive'; whereas at the end-point of the reaction only 33% of those total traits were viewed as 'attractive'. In other words, when the couple began to break up the 'repulsive force' of certain select traits in the bond, Mx≡Fy, e.g. reliability, which may have previously resided in mental dormancy, began to take over in the mental state of the relationship. Interestingly, the perception of physical attractiveness discerned by this woman, traits such as beauty, youth, good looks, etc., all were neurologically transformed into 'repulsive' traits by the time the relationship terminated. In other words, the repulsive force functioned to physically break up the union, i.e. to change what were 'positive' or attractive traits of the mate into 'negative' or ugly traits.

To elaborate, according to noted American human relationship and sexuality researcher Vern Bullough, as found in the foreword to Anthony Walsh's 1991 book *The Science of Love*, 'love is something we can examine, analyze, and perhaps even begin to explain. It is not only poets who are authorities on love: scientists, too, of various sorts, from biologists to sociologists, from physicists to psychologists, have been interested *in what attracts and repels*.'

In short, there is a certain 'tipping point', during the course of bond breakage, in which repulsion begins to predominate over attraction. The great English physicist and mathematician Isaac Newton was the first to discern this subtle point. In the famous 'Query 31' to his 1704 *Opticks*, after stating his chemical bonding theory in which 'particles attract one another by some *force*, which in immediate contact is extremely strong, at small distances performs the chemical operations, and reaches not far from particles with any sensible effect.' He then clarifies that within these bonds there exist attractions and repulsions. Specifically, Newton states:

> “As in algebra, where affirmative quantities vanish and cease, there negative ones begin; so in mechanics, where attraction ceases, there a repulsive virtue ought to succeed.”

Newton also states that there are ‘agents in nature’ able to make the particles of bodies stick together by very strong attractions. Today we know, quite accurately, that Newton’s adhesion agents are force quantities called ‘gauge bosons’. In particle physics, *bosons*, which are named after Bengali Indian physicist Satyendra Nath Bose, are elementary particles having integer spin, which function to create exchange forces. In short, bosons carry the force.[69] The boson called the ‘photon’ is Newton’s agent responsible for chemical bonding.

In regards to the G{H,S} column, we see representative enthalpic and entropic quantifiers of each mate selection trait. Sincerity, the most desired trait, is quantified by two types of entropies, S_P, i.e. entropy associated with personality, social graces, character, and dependability, and S_N, i.e. entropy associated with inner nature, values, and ambition. Likewise, youth, a highly sought after quality, is quantified by H_{AGE}, i.e. enthalpy of age. Thus, through [2.1] we can discern how the various mate traits act as guide posts on thermodynamic free energy maps, in relation to mate selection.

In the various fluid-substrate systems of the body, as discussed, the mapping of the thermodynamic affinity of receptor-ligand pairs prior to the interdigitation of their surfaces reveals two mechanisms of protein-protein recognition, one dominated by long-range electrostatic steering forces, i.e. generalized potentials, and the other by short-range forces, i.e. locking potentials. These long range and short range steering forces, in turn, can be mapped satisfactorily through attractive and repulsive free energy interactions, in which binding entails, for at least one of the protein molecules, a diffusional search for its target.[79]

Similarly, in the various air-fluid-substrate systems on land, the mapping of the thermodynamic affinity of single human molecules prior to interdigitation of their surfaces with others, i.e. sexual intercourse, should reveal two mechanisms of mate-mate recognition, one long range, the other short range. As such, from the G{H,S} column in 60-trait table, we can discern thermodynamic free energy landscapes of human-human interactions, thus showing that the chemical affinity of the ligand (mate) and receptor (host) is a necessary condition for binding.[79] One female human molecule, for instance, may have a ‘love for children’ S_N long range mate selection steering force, i.e. a *must-have* in their potential mate, and a high ‘intelligence’ S_I short-range locking potential as a clincher trait for their desired marriage.

Gottman stability ratios

In all human relationships, an ever-present amount of 'balancing' or stabilizing attraction and repulsion reactionary tendencies function to facilitate the formation and dynamics of human bonding.[70] In stable long-term marriages, as mentioned, a *5-to-1 ratio* of attraction-to-repulsion functions as a stabilizing ratio. This bonding ratio is called the *Gottmann stability ratio*, named after MIT mathematician John Gottman who discovered the dynamic ratio in the 1970s, after video recording the interactions of several hundred married couples.[51] All couples in romantic relationships have such a force exchange ratio.

The closer an exchange ratio is to 5-to-1, the more stable is the bond. In other words, even though one thing might drive a person crazy about their mate a stable pair would still stay in love and in marriage as long as there are five likeable things to balance every one irritation. In short, the decisive factor in a relationship is not how much people like each other or how many good qualities one has, but rather how many irritable qualities there are in the bond. Owing to this ratio, repulsive qualities are inherently more powerful and decisive than attractive qualities.

When repulsion in bonds tends to predominate at a higher ratio than this, such as 5-to-2, divorce or relationship breakup is inevitable, i.e. unless a significant isomerization (reconfiguration) reaction (change) occurs.[71] People in long-term relationships, for instance, will spend five times as much time talking in a response to a question about their partner's positive qualities as they do about negative qualities, and tend to qualify comments about negative qualities by explaining away their importance.[72]

Many researchers naively assume that attraction is a unidimensional variable or that attraction alone is the single factor in determining the outcome of a potential bonding relationship. This, however, is a misnomer. Some, for instance, will argue that attraction and repulsion are mirror images of one another and that the more we dislike someone or some aspect of someone, the less we like him or her.[64] In such a conception, then, one's attraction toward another can vary from extreme attraction to extreme repulsion. Moreover, some have considered the possibility that negative and positive feelings associated with a single person might be relatively independent, meaning that one might feel both extreme attraction and extreme repulsion toward the same individual.[64]

In regards to the physical characteristics associated with either attraction or repulsion, Ford and Beach, in the 1950s, made pioneering discoveries in this area.[73] By analyzing cross-cultural variations in values of perceptions of beauty, Ford and Beach were able to discern universal cues that point towards an evolutionary theory of physical attractiveness. As determined by their research, signs of youth, such as clear and smooth skin, signs of health, such as absence of sores and lesions, cleanliness, and freedom from disease, etc., are all universally regarded as sexually

attractive. In contrast, physical indicators such as poor complexion, pimples, ringworm, facial disfigurement, and filthiness are considered sexually repulsive.[13]

Among the Trobriand Islanders in northwestern Melanesia, for example, anthropologist Bronislaw Malinowski reports that 'sores, ulcers, and skin eruptions are naturally held to be specially repulsive from the viewpoint of erotic contact.'[74] Indicators, for the islanders, held to be especially attractive, from the view point of erotic contact, in contrast, are health, strong growth of hair, sound teeth, smooth skin, bright eyes, and full and well-shaped lips.

Attractors and repulsors in these terms are easily discerned. In terms of the atomic photon-electron interactions that mediate these tendencies, however, the picture becomes more complicated to describe. Nevertheless, human molecules, inherently, have evolved out of pre-galactic hydrogen-helium atomic interactions and dynamics. As such, atomic attraction and repulsion tendencies are inevitably conserved in the form of reactionary impulses, stored in the human central nervous system. In happy marriages, i.e. stable dynamic bondings, for example, there tends to be a balanced five-to-one ratio of attraction to repulsion. In unhappy marriages, there tends to be ratios of attraction-to-repulsion greater than or equal to five-to-two, i.e. repulsion tend to predominate. Wives, for example, who make sour facial expressions, i.e. a negative repulsive reaction, when their husbands talk are likely to be separated within four years.[51]

The research findings for these ground-breaking bond stability measurements were determined by American mathematical psychologist John Gottman. In the 1970s, Gottman began conducting interviews with married couples that were on the verge of breakup. One day, on a whim, he decided to video record one couple's interactions so to take a closer look at their dynamics using the scientific method. Later, after statistically analyzing and studying these video clips, interaction by interaction, Gottman began to notice an interesting pattern: couples with too much negativity in their bond, i.e. repulsive exchange, were headed for divorce. In other words, according to Gottman, there are emotional currents and elusive forces at work in human relationships.

From 1983 to 1986, his research team monitored more than a hundred married couples in Indiana and Illinois with electrodes, pressure sensors, video cameras, and microphones as they attempted to work out real conflicts. Using the information derived from these sessions, Gottman concluded that a stable marriage can be expressed mathematically: *the ratio of positive to negative moments must be at least 5:1*. Gottman describes his findings and studies as being akin to a CAT scan of a living relationship.[75]

Several years later, after repeating this video analysis procedure with over 2,000 married couples, Gottmann was able to foretell, with an astonishing 94 percent accuracy, which couples were headed for divorce three years later. In other words, using video attraction-to-repulsion statistical analysis, he was able to predict the

outcome of human chemical marriage reactions. In 1994, Gottmann presented these ground-breaking studies in his phenomenal best-selling book *Why Marriages Succeed or Fail*, in which he declared that he has discerned the 'hidden natural laws of relationships' that mediate via invisible emotional currents.

In this exceptional book, Gottman details how over twenty years his research teams have compared, microsecond by microsecond, how couples talk to each other, exchange facial expressions, how much they fidget, how they gesture, how their blood pressure or breathing rate changes, etc. Through these studies, Gottman mapped facets of sarcasm, contempt, humor, attitudes, and emotion, etc., so to map out the processes that lead either to the dissolution of a marriage or the formation of one. Gottman calls these basic interactions *marriage dynamics* and attributes these spontaneous changes to a physiological and emotional reaction that occurs between all couples.

When analyzing the tapes, at a slow microsecond speed, exchange data such as the emotional content of person's words, facial expressions, gestures, or body movements, are divided into three groups: positive, neutral, or negative. In more detail, these can range from disgust, contempt, belligerence, validation, affection, or joy, which can each be digitally coded at each moment of the interaction. In other words, all of the many hundreds of sensor inputs, such as the visual sight of a sour facial expression, of any human conversation create a reactionary state of either attraction or repulsion in the recipient. Attraction tends to create cohesive dynamic movements and behaviors, whereas repulsion tends to create receding dynamic movements and behaviors.

At the sub-microsecond speed, exchanges are mediated by photons. The rate at which human molecules absorb, process, and emit field particles, or emotional current, is 15-cycles per second.[76] Therefore, if any 10-second video segment or interaction between two people in conversation is analyzed by slowing the video down to micro-frames of $1/45^{th}$ of a second, one will see, by watching the slowed-down version, frame by frame, what is called *interaction synchrony*, in which the conversation takes on a rhythmical structure. One will see, for instance, each person, within the space of one, two, or three $1/45^{th}$-of-a-second frames, move a shoulder or cheek or an eyebrow or a hand, sustain that movement, stop it, change direction, and start again. In other words, the timing of the stops and starts of each person's micromovements, i.e. the jumps and shifts of body and face, with respect to his or her bonded companion's response, are found to be in perfect harmony, having a frequency of 15-cycles per second.

The sum process is akin to a champion ping-pong match of emotional exchange (thermalization); each catches the other's emotion, then rapid fire sends back the response. If, however, the pair is in a state of *bonding dissolution*, meaning they are headed for a break-up, the exchange process will become disharmonious. The mental register of a mate's sour facial expression, for instance, will require time-

extended neurological processing, thus slowing down the energy exchange rate involved in the evolution. This extra energy use quota constitutes entropy loss through what would be termed *mental friction* in the bond, meaning that the second law of thermodynamics is at work, dissipating energy *in* the relationship, and that less and less energy is being left available for purpose or functional external useful work, *outside* of the relationship.

To tie this together with the combined law of thermodynamics [4.27], it is known that any two objects, surfaces, or molecular structures may either 'attract' to or 'repel' from each other for a variety of reasons. Attributed to each of these situations is a corresponding *Gibbs energy of attraction*, symbolized by G_a, or *Gibbs energy of repulsion*, symbolized by G_r; both of which are a result of quantum electromagnetic effects.[77] The Gibbs energy of repulsion for two surfaces coming close together, for example, is defined as follows:

$$G_r = \left[\int_{final-dis\tan ce}^{\infty} Force \times dis\tan ce \right]_{T,P} \qquad [6.13]$$

The Gibbs energy of attraction for this case is similarly defined:[77]

$$G_a = \left[\int_{final-dis\tan ce}^{\infty} Force \times dis\tan ce \right]_{T,P} \qquad [6.14]$$

In physics, a force times a distance gives a measure of work energy associated with the dynamics of the process. Thus, for each $1/45^{th}$-of-a-second interaction between any two human molecules, a microsecond Gibbs free energy of the interaction can be calculated. The sum of these free energy interactions constitute the working energy associated with driving force for the process. The sum of all such reaction processes constitutes the human evolution.

Further extrapolation of this principle, or derivations of equations similar to [6.13] and [6.14] for the human bonding scenario, in relation to interpersonal human working relationships is the next obvious step. More research will be needed in this area. Herein, we will not attempt to derive such analogous equations, but will only outline this perspective verbally.[78]

7 – Bound State Interactions:

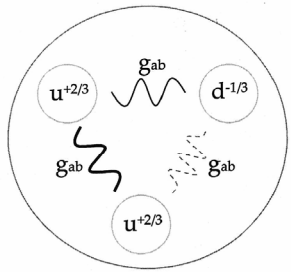
"Human connections shape neural connections
from which the mind emerges."
Daniel Siegel, *The Developing Mind*

At the heart of the story of life, lies the basic understanding that networks of things of all kinds, such as atoms, molecules, relationships, species, people, and even ideas, have a marked tendency to organize themselves.[1] The fundamental dynamic of evolution, which characterizes the process of life, from one perspective, is based on time-enhanced changes in what are called *power relationships*, which are distinguished by the ability of one entity to influence the action of another entity.[2] In 2005, for instance, philosophical thermodynamicist Lawrence Chin stated 'why does a collection a collection of people, each of whom has a totally free will and independent interests, somehow behave together in a way as to have a perfectly predictable average? The masses behave just as a collection of particles.'[3]

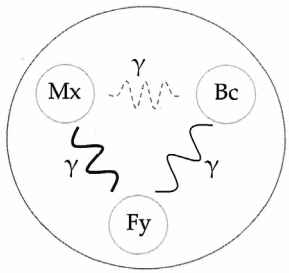
In this manner, structures such as quarks, electrons, atoms, people, companies, or governments, etc., can be viewed as single, coherent quantities exerting influence on one another. Together, these structures are networks of bonded entities connected through dynamic power-relationships from which the whole emerges. The process of life, subsequently, is a type of atomic time-enhanced 'particle evolution' in which energies and interactions have coalesced and collided, in a periodic manner, to form newer, more complex entities. The essential structure of importance in human life, or course, is the human molecule, a twenty-six element entity. In this chapter, based on the logic of particle physics, we will define the human molecule, to be a *bound state* atomic structure, of approximately 10^{27} atoms, linked together via photon-electron binding interactions.

> **Bound state** – a composite of two or more fundamental building blocks, such as particles, atoms, or bodies, that behaves as a single object and in which energy is required to split them.[4]

Subsequently, examples of bound state structures include the proton, which is a bound state of three quarks, the atomic nuclei, which is a bound state of protons and neutrons, and a molecule, which is a bound state of atoms. Thus, not only is a human molecule scientifically defined as a bound state composite structure, but also so is a married couple, which is a bound state of two human molecules. A family, similarly, is a bound state structure of three or more human molecules, as diagramed below:



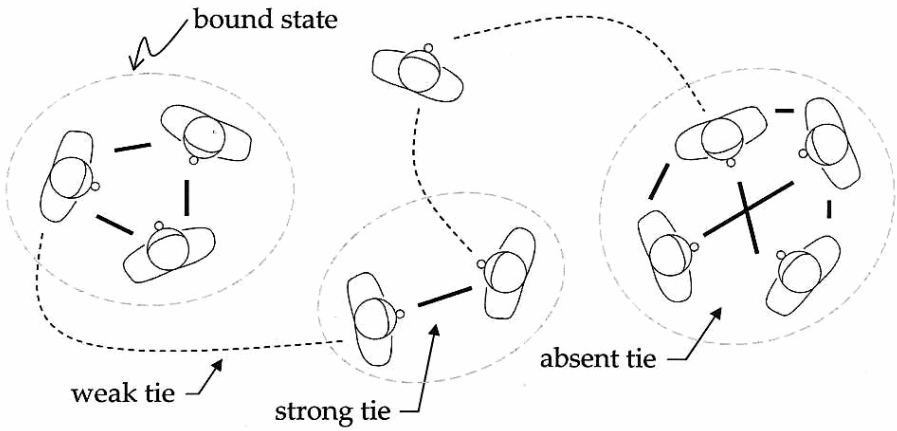
Proton – a *bound state* of three quarks



Family – a *bound state* of three humans

This terminology, likewise, applies to larger structures such as groups, friendships, networks, corporations, countries, a solar system, or even galaxies. Galaxies, for example, are cohesive bound states of star systems. Collections of galaxies, in turn, congregate to form what are called *galactic clusters*, which are also bound states.[5]

Herein, subsequently, we will observe human interactions at a distance such that each human is seen or visualized as being a small point of undefined bound mass, symbolized by a finite dot '●', moving on an approximate two-dimensional surface, such as would be the view through a large advanced-intelligence *macroscope*. Thus, at normal resolution, as shown below, we see what collectives of associative human molecules look like, from above, as they collide, move about, dynamically interact, and exchanging quantities, such as information, gossip, pheromones, emotions, physical contact, financial resources, visual reflections, vocal intonations, genetic material, etc:

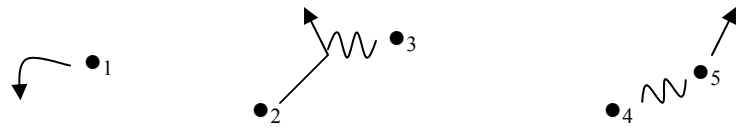


Links shown, as solid lines (strong ties), dotted lines (weak ties), and no lines (absent ties) are modeled on the 1973 theories of American sociologist Mark Granovetter, from his famous article 'The Strength of the Weak Ties', which is recognized as one of the most influential sociology papers ever written.[6] Weak ties and strong ties in human life, according to Granovetter, are analogs to hydrogen bonding (weak bonds) and covalent bonds (strong bonds) in societies of water molecules:

Topological dynamic movements, from this perspective, can be defined as neurologically processed reactions to exchanged sensory inputs. In other words, reactionary human molecules take in sensory inputs, mentally process them, and dynamically react or move accordingly.

To facilitate this viewpoint, using the advanced perspective, we will substitute dots for humans. This is analogous to how atoms, for many years, were labeled as dots or points before their internal structure was discerned in the early twentieth century. This particle movement view will be combined later with internal particle views, namely biochemistry and neurochemistry (chapter twelve). The science of *biochemistry*, which studies the chemistry of the body, stems from French chemist Anselme Payen's 1833 discovery of amylase, an enzyme that breaks down starch.[7] Likewise, the science of *neurochemistry*, which began in 1954 following a series of interactive international neurochemical symposia gatherings, chemically studies the brain.[8] In sum, the dynamic, particle perspective of physics, which studies the effects of forces on particles, the biomolecule perspective of biochemistry, which studies internal body chemistry, and the neuromolecule perspective of neurochemistry, which studies brain chemistry, will together yield a cogent unified picture of human chemistry, the study of human molecules.

With this fundamental neuro-bio-physics human chemical perspective as a basis, to simplify things, if we study human movement dynamics from the point of view where humans are bound-state points moving on a map we would arrive at the following example diagrams, which we will label as *human particle maps*:



Human particle maps – humans interacting via field particle exchanges

In these maps, the numbered dots represent different people, arrows represent movement, direction, and momentum, and waves represent exchanges. In theory, using computer technology, all human movements and exchanges can be satellite tracked and recorded, in such a manner as is currently done with high-energy particles in particle accelerators and similar predictions and theoretical discoveries would result.

In human life, an example of a high-energy human particle accelerator might be akin to something like the MTV show *The Real World*, where the high-energy lives of seven random strangers are selected, based on heightened chemical personality and physical reactivities, and channeled into a videotaped three-month collisional reactor vessel. Personalities and physical attraction differences collide, conflict, or coalesce and the world studies the resultant scattering effects similar to how

physicists study particle collisions. *The Real World*, which started in 1992, and *COPS*, which started in 1989, are the two longest-running reality shows of all time.[9]

In each of these collisional scenarios, which involve short-lived heightened energy states, we will study how human particles are either intensely attracted, adamantly repelled, or remain uncertain or ambivalent to each other. Attractions and repulsions, generally, are unconscious reactions to dynamic exchanges, whether physical, emotional, or otherwise. These reactions, subsequently, result to yield spatial reconfigurations and reactive movement dynamics. That is, people who 'like' each other tend to aggregate, whereas people who 'don't like' each other tend to separate or disaggregate.

To summarize, humans, for analysis purposes, can be thought of as particles, which can be videotaped, satellite-tracked, and analyzed. Satellite tracking of humans as points is becoming more commonplace. In 2007, as an example of a technology that enables human tracking, engineers unveiled a new line of GPS shoes to make people findable.[10] Likewise, Disney recently developed subscriber cellular phones in which worried parents can satellite track the whereabouts of their children from their home computer. A point to note, however, is that while these bound states of human particle mass would occasionally be seen moving in three dimensions, e.g. flying, swimming, jumping, or climbing, etc., for most purposes herein we will study only two-dimensional interactions, e.g. crawling, walking, running, or driving, etc. This particle approach, essentially, is what chemistry is based on. Chemistry, historically, is structured on the concept of particles, specifically nuclei, electrons, and photons, interacting with other particles. Thus, if we are to apply chemistry to human life, then we must first view the human as a point of undefined mass, and from this perspective intelligently study related dynamic phenomena such human reaction mechanisms, human chemical bonding, reaction extent, etc.

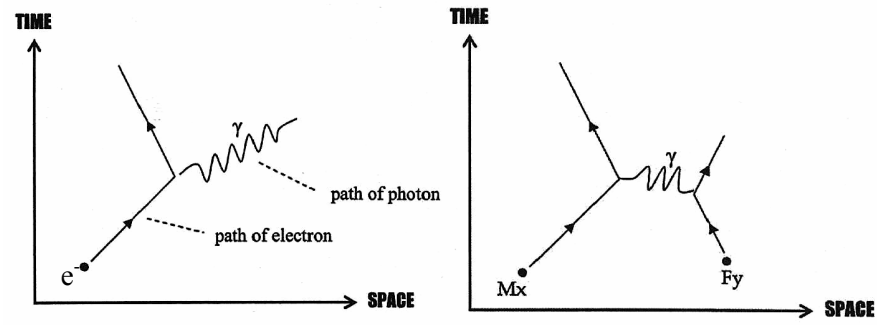
We will define this perspective as 'bound state resolution', in which the human entity is viewed as a bound state of mass, symbolized by a dot ●, moving on a two-dimensional surface, interacting with other such dots via exchanges of force-carrying particles, such as a photon γ, which are symbolized by wavy lines.

Feynman diagrams

Pictorially, in physics, we model these types of interactions using what are called *Feynman diagrams*, in which moving particles (arrows) interact with one another by the exchange of a field particle (waves).[11] These basic particle interactions, in physics, typically occur within a three-dimensional volume of space, which can be computationally mapped and tracked on a computer. In human chemistry, we will apply this logic to reactions occurring over substrate, in which the gravitational force becomes negligible and the electromagnetic force of interpersonal interaction

becomes significant. In short, Feynman diagrams are advanced versions of human particle maps.

Exchanges, by definition, actuate to change the resultant behavior, character, and movement patterns of the interacting particles. Shown below, are two basic interactions detailed using Feynman diagrams:



To the left, is a basic photon-electron interaction, in which an electron e^- releases a photon γ and has its direction and momentum changed as a result. To the right, is a mutually repulsive visual interaction between two human particles, in which a negative or unpleasant visual glare is released by a man *Mx* moving along his path. The information content of the glare, in the form of vibratory packets of photons γ, functioned resultantly to change his direction and momentum. Following the release or reflection of this glare, its visual imprint was carried to a woman *Fy* who reacted to this sensory absorption by changing her path away from the man.

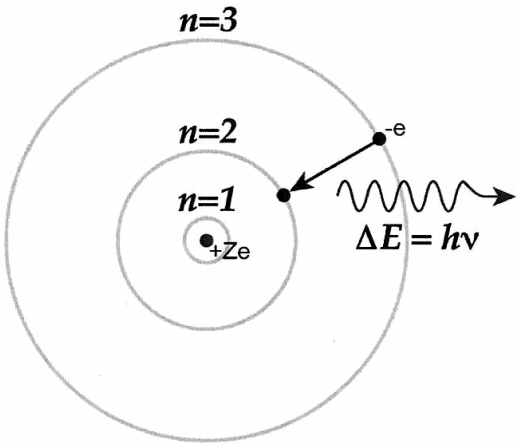
The arrows, in Feynman diagrams, are called 'world lines' and represent the position of a particle, such as an electron or human, in space over time. A vertical line indicates a stationary particle because its position is not changing in space over time. The more angled the world line, the greater its rate of change in position in space and therefore the faster it is moving.[12] In simple terms, the above diagram, to the right, could represent two people strolling along a beach who happen to exchange an unwelcome glance, sound, or scent that resultantly functions to repel them apart, however slightly.

Feynman diagrams were developed in the 1940s for use in quantum field theory, by American physicist and Nobelist Richard Feynman.[13] They were necessary to explain the various effects of forces on particles. In particular, the finding that the exchange of a field particle, such as a gluon, can produce a force was one of the most profound conceptual advances in physics.[14] It is along these lines that Feynman diagrams were developed and it is in this manner that we will used them in human chemistry to quantify forces in human life.

In sum, Feynman diagrams are used principally for interactions in particle physics; in theory, however, they are applicable to all types of interactions. We will use them here to model human interactions. In this manner, human bonding can be

understood in terms of proximities of adjoined human particles and the exchanges or forces that keep such bonded particles in temporal proximity.

We justify the use of these diagrams in human life based on the knowledge that all human interactions are quantum electromagnetic in composition, i.e. due to the interactions between electrons and photons.[15] The following diagram shows the basic relationship between the interactions of outer shell electrons e^- and photons γ, shown by the wavy line, a light particle whose energy equals $h\nu$, where h is Planck's constant and ν is the frequency of oscillation of the light wave.



Bohr Model of the Atom

In this atomic diagram, $+Ze$ is the total positive charge of the nucleus, which is typically equal to the total number of negatively charged electrons e^- in orbitals of the atom, and $n = 1, 2, 3,$ etc., are the various s-shaped electron orbitals.

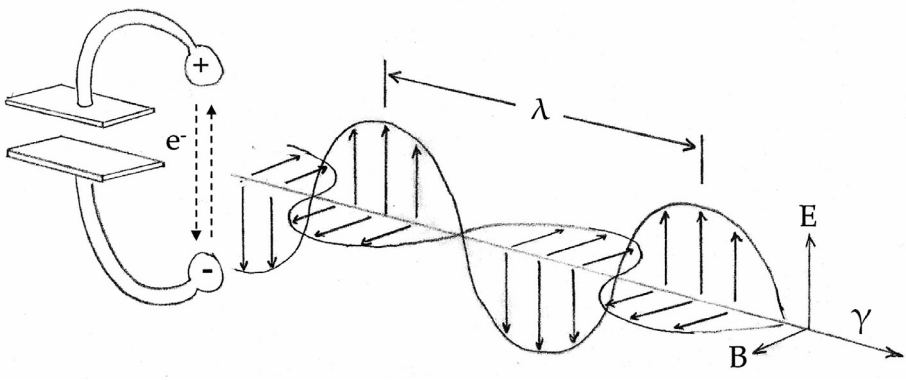
In short, when an electron moves into a lower energy orbital, it is a stabilizing move that accompanies the release of a photon. Conversely, when an electron moves into a higher energy orbital it is a de-stabilizing move that accompanies the absorption of an electron. The stability of atoms is an involved subject, but essentially atomic orbitals with even numbers of electrons in them are more stable than orbitals with odd numbers of electrons and outer valence shells filled with eight electrons are extremely stable. Atoms and the molecular structures they are imbedded within will tend to evolve or reconfigure in directions that will satisfy these stability rules.

In simple terms, this means that whenever two human molecules, which are comprised of these stable/unstable electron valence shells, exchange something, via valence shell photon-electron interactions, such as a glance, a touch, a word, emotion, food, money, scent, or germ cell genetic material, etc., the changes in the atomic structure of the human and the neurological mechanisms associated with each exchange will, on average, trigger the human molecule to reconfigure towards

stability. Not all molecules, however, will configure towards stable arrangements; some will be predisposed to reconfigure towards instability, e.g. illegal activites.[16]

In chemical dynamic terms, all human interactions result owing to quantum electromagnetic interactions or exchanges between the outershell valence electrons in the atomic structure of the human molecule involved in the exchange, the quantity exchanged, and the surrounding photonic field. In other words, photons impinge on the outer electron-shell portion of the human bond, this 'forces' a conditioned or processed response, and a person is thus forced to neurologically choose or to make decisions because of these photonic inputs.[17]

In the surrounding electron-shell structure of the human body, these electron-photon interactions occur continuously. Normally, when electrons are confined to their normal rotating orbitals, these interactions are not sensed. When, however, a photon, in the surrounding environment, contains the requisite amount of energy, in the correct frequency, it can 'force' a sensory electron to change orbitals. When this happens, the body registers this as system information and is forced to react or responds accordingly. The basis of this model was established in the 1930s, when two physicists, the German Hans Bethe and the Italian Enrico Fermi, suggested that interactions between charged particles could be described in terms of photons being exchanged between particles.[12] This theory, was a modification of the older 1864 discovery by Scottish physicist James Maxwell that light consists of oscillating and perpendicular electric *E* and magnetic *B* fields, as shown below:



Propagation of an electromagnetic wave

An electromagnetic wave can be created by events such as a discharging spark, an oscillating molecular dipole, or an electron orbital change. In this diagram, γ is a photon, λ is the wavelength of the light, *E* is the amplitude of the electric field, and *B* is the amplitude of the magnetic field. The frequency is the number of complete oscillations per second of energy in the form of waves.[18] The frequency of a wave has an inverse relationship to its wavelength. Frequency, in general, is equal to the speed of the wave divided by the wavelength λ of the wave:

$$\nu = \frac{speed}{\lambda} \qquad [7.1]$$

In the special case of electromagnetic waves moving through a vacuum, then *speed* = *c*, where *c* is the speed of light in a vacuum, and this expression becomes:

$$\nu = \frac{c}{\lambda} \qquad [7.2]$$

When waves travel from one medium to another, their frequency remains exactly the same, only their wavelength and speed change. Apart from being modified by the *Doppler effect*, i.e. the change in frequency and wavelength of a wave as perceived by an observer moving relative to the source of the waves, or any other nonlinear process, frequency is an invariant quantity in the universe. That is, it cannot be changed by any linearly physical process unlike velocity of propagation or wavelength. Frequency is also a measure of temperature, as for when the temperature of a molecule is increased it will vibrate faster. The faster the molecule will vibrate the higher the frequency.[19]

It is now understood that electromagnetic fields are made up from photons, in which electric and magnetic forces are assumed to be due to the action of photons.[20] While it is easy to imagine that light to be due to a stream of photons, it is hard to see how an electric field, for example, is due to photons. This is a more advanced topic that requires the use of the concept of the mass-shell. The photons associated with the electric field, for example, are different than the photons of light; in particular, the photons of light are 'on the mass shell', those of electric and magnetic fields are not. In physics, particularly in quantum field theory, configurations of a physical system that satisfy classical equations of motion are called *on shell*, and those that do not are called *off shell*.[21]

In general, in the earth system, evolutionary dynamics actuate because photons γ exchange between the outershell valence shell electrons within the atomic orbitals of adjacent atoms and molecules within the biosphere. Atoms release photons γ when they stabilize, where an electron e^- moves into a more stable 'lower' orbital, thus moving the structure of the atom into a low-energy state. Conversely, atoms absorb photons when destabilizing, where an electron moves into a less stable 'higher' orbital, thus moving the structure of the atom into a high-energy state. The higher the energy state of an atom or group of atoms the greater its rate of vibration and movement. When an atom, or the molecule to which it is attached, is in an excited or unstable state it will tend to reconfigure towards stability, expending work energy along the way to get there. This is the essence of evolution.

In order to gauge these evolution tendencies in human life, in the future, human state instruments will be needed. One example of this, is *Vibraimage*, a non-invasive facial image mapping technology, in which the vibration rate of the video pixels of a

person's face, in animated dynamic motion, can be computationally translated to gauge the internal emotional state of an individual.[22] This is an example, of a potential or future type of human *thermodynamic instrument*, namely that which can help to gauge variables such as the internal energy U of a system of reactive humans.

In modern terms, we now understand that electromagnetic fields are made up of photons, meaning that light has both a wave and particle composition.[23] Although there are still questions to be answered, such as how gravity operates or how one photon (or one electron) can simultaneously go through two slits (the double slits experiment), these quantum electrodynamic theories explain why chemical reactions take place. Thus, knowing that human life is a chemical reaction, as is argued herein, quantum electrodynamics thus accounts for all person-to-person interactions including romance. The primary electron orbitals (valence shells) in the human body in which photonic actions are active are called 'supramolecular receptors' or sensors for short. Atomic stabilities and instabilities created or actuating in these supramolecular receptors by the impingement of sensory photons in the environment surrounding a person combine to instill states of stability or instability in the subconscious of the person. These instabilities, on average, will drive a person in directions that will best tend to alleviate these pressures.

Supramolecular receptors

Sensory stimulation is what drives human life, without it life ceases to function. In 1952, studies at Montreal's McGill University, for example, showed that when researchers eliminated the interaction of sight, sound, and, with the use of padded gloves, tactile stimulation with the sensory receptors of study participants, subjects were found to descend into a hallucinatory state in as little as 48 hours.[24] Sensory receptions, subsequently, are essential to normal life. Human molecular sensory processes, e.g. *chemosensation*, in which is a cell or group of cells detect certain chemical stimuli in the environment, can be thought of as being driven or forced into inception via photon-electron interactions at the periphery of the human body, areas including the skin, eyes, taste buds, vomeronasal organs, etc.[25]

These interactions, thus, combine to instill or force a mental state of central neurological processing, which actuates according to combinations of neuronal voltage potentials, synapse neurochemical concentration flows, electrochemical axonal and dendritic currents, which themselves also produced mini neuro-fields, that together yield to its recipient a timed-reaction of conscious response. In other words, forces in the environment of a person drive various neuro-electro-chemical processes, otherwise known as consciousness.

In simpler terms, interactive processes actuate between two people such that, in the poetic words of American psychologist Ruthellen Josselson, 'whatever happens between us will create some emotional response in me as well as a change in my

image of you and my image of myself. The changes in my image of you and of myself will also influence how I will treat you in the future. What happens between us will likewise affect you in your thinking about me and will influence how you treat me in the future.' Hence, when people talk about their own lives, a natural recursive language is used in substitution for what is invariably a quantum-neuro-electromagnetic process.[26]

Photons, to review, are the carriers of the electromagnetic force. These are the prime movers in human life. The prime movers in the universe, however, are the four fundamental forces, namely the gravitational, strong nuclear, weak nuclear, and electromagnetic force. The carriers for the gravitational, strong nuclear, and weak nuclear forces are the *graviton*, the *gluon*, and the *boson*, respectively.[27] Feynman diagrams, interestingly, are applicable to all four of these force interactions. These scientific details are all very clear, yet when it comes to the direct application of these forces with respect to their function in mediating the human sensory system, the picture becomes more complicated.

An oft-quoted figure states that eighty percent of our sensory system is visual in magnitude.[28] This would indicate, knowing that the visual sense is directly mediated by photon exchanges, that the major diving force in human life is vision. Yet, when people are queried and asked 'in terms of percentages, how much does the body use each of the five main sensory systems on average?', the following mean answers will result:[29]

SENSE	% of Perception	Messenger Particle
Sight	37	direct photon exchange
Hearing	23.7	indirect photon exchange (air molecules)
Touch	18.9	direct tactile photon exchange
Smell	12	indirect photon exchange (scent molecules)
Taste	8.4	indirect photon exchange (taste molecules)

These five senses, naturally, are the body's best-known information receptors. In addition, we also have a *kinesthetic sense*, e.g. when we are accelerated, we have *thermosensors*, which registers subtle or minute temperature fluctuations, we have *mechanosensors*, which register pressure changes, the *vestibular system* within our ears keeps us in balance, we sense the direction of the earth's magnetic field about us, which causes us to rotate either clockwise or counterclockwise depending on our latitude, and we can sense various hues of mental thoughts, e.g. animals can sense seizure activity in humans twenty minutes prior to the seizure happening.[30]

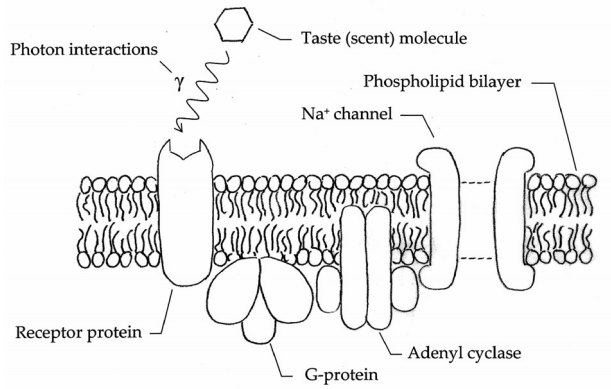
This is only a partial list. The point to note, here, is that during any random human particle interaction, billions of photons are exchanged per microsecond and not all of these exchanges, such as two people whispering into each other's ears, are visual. Some photons, for example, will impinge on the human body, not due to reflected light photons, but rather due to the impact of a molecular structure, such as someone's gentle touch or the vomeronasal docking of a volatile scent molecule. To

thus understand the effects of photon force carriers in human chemistry, in some cases, owing to the intricacies involved in many of these processes, approximations will be used. Nevertheless, often, a single dominate exchange or interaction is enough to crack the attachment bond between volatile couples. For husbands, according to one reviewer, visually seeing one's spouse secretly kissing another man to the side of the garage is enough of a visual stimulus to end a marriage or worse.

To summarize, for any forced interaction in the universe, the force particles might be, for example, quarks interacting by the exchange of a gluon g_{ab}; electrons interacting by the exchange of a photon γ; humans interacting by the exchange of an aromatic volatile scent molecule, such as camphor $C_{10}H_{16}O$ (a wood scented molecule) or a pheromone (a conspecific molecule), or galaxies interacting via exchanges of gravity particles called gravitons.[31] Quarks, as mentioned, comprise the structure of protons and neutrons.

A *pheromone*, by definition, is any chemical or set of chemicals produced by a living organism that transmits a message to other members of the same species. The term 'pheromone' was introduced in 1959 by biochemists Peter Karlson and Adolf Butenandt, based on the Greek *pherein* (to transport) and *hormon* (to stimulate). They proposed the term to describe chemical signals from conspecifics, i.e. those of the same species, which elicit innate behaviors.[31] Examples are 'alarm pheromones', 'food trail pheromones', 'sex pheromones', and many others that affect recipient behavior or physiology. The volatile molecule Bombykol $C_{16}H_{30}O$, for instance, is a well-characterized pheromone released by the female silkworm, used to attract mates from as far as fifteen miles away.[32] In mammals and reptiles, pheromones may be detected by the vomeronasal organ, or Jacobson's organ, which lies between the nose and mouth, although some are detected by regular olfactory membranes.

A quantity such as a pheromone, technically, is not a field particle per se, but will be treated as such here being that its path is guided in a diffusive manner through the atmosphere due to photon-electron interactions, which cause diffusion to mediate in a wave-like manner. An entity such as a pheromone or a scent molecule, from another perspective, carries a requisite amount of energy, which can function to trigger a 'quantum' stimulus in the receptor to which it attaches. These quantum triggers, in mechanism, are quantum electrodynamic. The following basic membrane diagram, called a *chemosensor*, to clarify, shows the chemical mechanics for the reception of either a taste or a scent molecule at the perimeter of the human body:



Taste or scent molecule receptor diagram

The senses of smell, called *olfaction*, and of taste, called *gestation*, are both forms of chemosensation, in which the body uses specialized membranes to chemically sense and respond to the surrounding environment. In terms of smell, first photon-electron interactions in the surrounding atmosphere drive active odorant molecules through concentration gradients. When an odorant molecule has the correct shape it binds to a receptor protein. This binding action activates an adjacent molecular structure called a G-protein, which in turn activates a neighboring enzyme called adenyl cyclase. As a result, an adjoined sodium gate is opened, Na^+ ions rush into the cell, and action potentials are generated and transmitted to the brain. The brain responds, subsequently, by unconsciously moving the body of the human molecule either towards or away from the stimulus, approximately.

In short, although an odorous molecule is not technically a field particle, i.e. that which carriers a force, we will treat it as such being that it produces the same effect as a field particle and because of the fact that its diffusive movements are mediated by interactions between atmospheric photons and the outershell electrons of the scent molecules. Said another way, atoms are held together in the form of structures called molecules via the exchange of field particles called photons; in similar manner, likewise, human molecules are held together in the form of structures called couples, friendships, corporations, etc., via the exchange of not only field particles called photons directly, but also, indirectly, via other field particle-like structures, such as pheromones. In sum, noting these complicalities, neglecting internal atomic details, for the moment, we will model humans as bound-state points of mass and track, map, and study their resultant interactions using time-enhanced Feynman diagrams.

Although simple in basic appearance, Feynman diagrams actually represent a collisional window of very complex interactions. Furthermore, the structure of each diagram obeys specific rules; in particular, each vertex, i.e. each point where

two or more lines meet, is in effect a shorthand notation for a series of complicated equations. In Feynman's own words, 'the diagrams were intended to represent physical processes and the mathematical expressions used to describe them.'[33] As such, using these Feynman diagram interactive maps we will model the human entity, a 'bound-state' unit of mass interacting with other such similar bound-state units of mass through the exchange of field particles.

In this direction, to better understand this new human particle perspective, in the following section we will elaborate further on related particle physics terms, such as: fundamental forces, fundamental particles, bound states, messenger particles, and how these related to human chemistry.

Fundamental forces

In physics, a *bound state* is a composite of two or more building blocks, such as particles or bodies, that behaves as a single object.[4] A *field particle*, otherwise known as a 'messenger particle' or force carrier, is a quantity of energy which carries or mediates the force; signified by a wave. In the physical universe, there are four known fundamental forces:

1. **Strong nuclear force –** mediates subatomic interactions.
2. **Electromagnetic force –** mediates atomic and molecular interactions.
3. **Weak nuclear force –** mediates radioactive decay processes.
4. **Gravitational force –** mediates interactions between objects with mass.

These forces, as noted, account for all movements in the universe, and operate via the exchange of field particles so aptly named: *gluons*, *photons*, *bosons*, and *gravitons*, respectively. Anytime a physical body emits or absorbs a field particle, its behavior and dynamics are subtly changed. These emissions and absorptions of field particles are what create dynamic movement patterns. To note, the graviton is a yet undetected particle, which may have relation to the electromagnetic force; we signify it here as the name give to the hypothetical carrier of the gravitational force.[27] These four field particles, together with a tabulation of their relative strengths and spins, are shown below (bolded are those most important in human chemistry):

FORCE	PARTICLE	STRENGTH	SPIN
Strong Nuclear	Gluons [g_{ab}]	Strongest	1
Electromagnetic	**Photons** [γ]	10^2 times weaker	1
Weak Nuclear	Bosons [W^+, W^-, Z^0]	10^5 times weaker	0, 1, or 2
Gravity	**Gravitons** [G]	10^{39} times weaker	2

In chemistry, *spin* is a quantum mechanical label used to describe the intrinsic angular momentum of an entity such as particle, atom, nucleus, or molecule, etc.[34] Spin can continue to exist even when a particle is apparently at rest, i.e. when its

translational motion is zero and therefore its orbital angular momentum is zero. The concept of elementary particle spin was first proposed in 1925 by physicists Ralph Kronig, George Uhlenbeck, and Samuel Goudsmit.[35] The concept of spin was first applied to the electron particle, in such a manner that two electrons will join together in proximity only when their spins are opposite.

Spin, basically, is a mathematical way of describing rotation; all mass in the universe rotates, the human-molecule included a phenomenon called *human molecular spin.* Particle spin, in a general sense, is complicated subject and will be addressed in a superficial manner herein.

Fundamental particles

These force carriers together with what are called the twelve fundamental particles, as shown below, constitute our current understanding of what is the known universe. Of these fundamentals, particles with integer spin [0, 1, or 2] essentially comprise the *energy* (*E*) portion of the universe – more generally known as the 4 fundamental forces; particles with ½ integral spin essentially comprise the *matter* (*m*) portion of the universe – more generally known as the 12 fundamental particles (those particles most relevant in human chemistry are bolded):[36]

QUARKS	SPIN	CHARGE
Up [u]	½	+2/3e
Down [d]	½	-1/3e
Charm [c]	½	+2/3e
Strange [s]	½	-1/3e
Top [t]	½	+2/3e
Bottom [b]	½	-1/3e

LEPTONS	SPIN	CHARGE
Electron [e]	½	-1e
Electron Neutrino [ν_e]	½	0
Muon [μ]	½	-1e
Muon Neutrino [ν_μ]	½	0
Tau [τ]	½	-1e
Tau Neutrino [ν_τ]	½	0

In general, the majority of terms here are not a primary concern in human chemistry. Together, these two tables represent the known universe, which can be further summarized by the following generalized law:

> **Law of universal composition** – everything in the universe is energy *E* or matter *m* or variations therein.[37]

In clearer terms, based on what is presently known about our surroundings (from small-scale subatomic data sets collected using the large electron-positron collider at Geneva to large-scale supragalactic observances obtained using the earth-orbiting Hubble space telescope), everything in the universe is found to be built from and presently interacting via relations to these sixteen fundamental entities: four force particles and twelve matter particles. All known phenomena observed both telescopically and microscopically function according to interactions of these sixteen

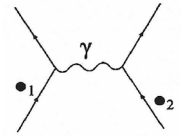
base entities. Hence, whatever question we probe this fundamental platform is our starting point.

A point to note, however, is that the counting of elementary particles is not an exact science, as it stands. The number of the fundamental particles must include a proper counting of particle variations such as spin, colour, flavour, degrees of freedom, etc. The total number of elementary particles may actually well be in the hundreds, once these subtleties are accounted for and possibly when new particles are discovered. This standard model, nevertheless, satisfactorily explains and accounts for the majority of dynamics in the universe; the problem of dark matter being one exception.

Messenger particles

With respect to bonding interactions, contrary to popular opinion bonds function to hold things together, not by solid or invisible bands of connection, but rather by the exchange of *messenger particles*.[38] These messenger particles, according to particle physics standards, show themselves to us as one or more of the four fundamental or 'primary' force particles, i.e. gluons, photons, bosons, and gravitons.

Hence, when two people ($\bullet_1$, $\bullet_2$) interact, the force-particle [~~~] could be a visual image (photons) reflected off the first person's body $\bullet_1$, or it could be a scent molecule (pheromone) exuded from the first person's body $\bullet_1$, or it could vocal information (speech) released from an oral cavity, and so on; the second person $\bullet_2$ could be a random body walking by who happens to receive or 'absorb' this mediated force-particle. Subsequently, the exchange of a force particle [~~~] between two bodies ($\bullet_1$, $\bullet_2$) unfolds according to the following four-step process:



Two people (human particles) exchanging a field particle

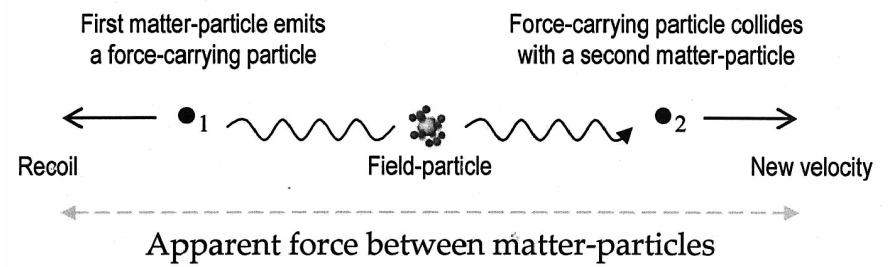
1. The first matter-particle $\bullet_1$ is moving ($\rightarrow$) with a certain velocity and direction.
2. The first matter-particle $\bullet_1$ then emits a force-carrying particle, e.g. a photon γ.
3. The velocity and direction of the first matter-particle $\bullet_1$ is then changed because of this 'emission', which actuates via a 'kick-back' sort of effect; analogous, in some situations, to firing a bazooka while standing on a frozen lake.
4. The force-carrying particle γ then collides with a second matter-particle $\bullet_2$, which results to change its behavior, velocity, and direction.

Each exchange process, subsequently, results to create either attractive or repulsive behavioral changes in the associated matter-particles. The cumulative effect of multitudes of these exchange processes functions or actuates to create or mediate an

'apparent' connective force between affected bodies. Technically, this attachment or detachment effect is what is called an *exchange force* or exchange interaction:

> **Exchange force** – a force whose apparent character lies in the assumption of a continuous exchange of particles, which accompanies the interaction and transmits the force, resulting from the continued interaction of particles in a manner that bonds their hosts together.[39]

The process of the exchange force receives its operational justification through the Heisenberg uncertainty principle.[40] The essential concept of exchange forces was introduced originally by physicists German Werner Heisenberg (1932) and Italian Ettore Majorana (1933) in order to account for the saturation of binding energy and of nuclear density.[41] This was done in analogy to the quantum mechanical theory of covalent bonds, such as exists between two hydrogen atoms in a hydrogen molecule: the chemical force is symmetric under exchange of the coordinates of the electrons and repulsive if the wave function is antisymmetric in this respect.[39] Pictorially, this exchange process is detailed below:[42]



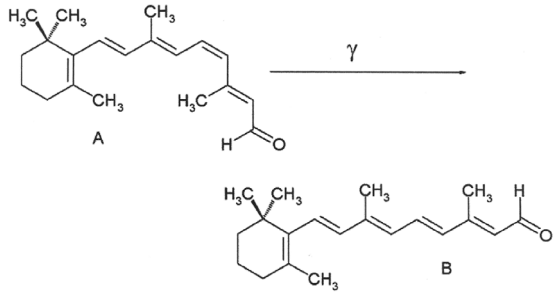
Apparent force between matter-particles

To clarify, in a dominant manner, the field particle exchanged in human life will be the photon directly exchanged in the vision process. Sunlight not only provides direct solar energy for the driving action of the food chain, via photosynthesis, but more importantly, it provides *information* to plants, animals, fungi, and microbes about their environment.[43] Information acquisition is what guides (drives) life.

Moreover, humans, like their relations the monkeys and apes, are intensely visual animals. Oxford zoologist Andrew Parker argues, in his 2003 book *In the Blink of an Eye*, that once the sense of vision developed five-hundred and fifty million years ago, there was enormous *pressure* to evolve. Components such as ornaments for mate selection, hard external parts for defense, or clasping limbs to grab prey became absolute necessities in the world of sight. This argument is no less true to this day. It can be argued, that the major driving force in human life actuates or is mediated by the sight of desirable objects.

In the retina of the human eye, the molecule that receives sensory photons is called retinal $C_{20}H_{28}O$. If the energy contained in a single photon is of the correct wavelength, between 400 and 700 nm, it will function to break what are called pi-

bonds found between the eleventh and twelfth carbon atoms near the kink in the structure of the retinal molecule.[44] When these pi-bonds break, this 'forces' the retinal molecule to rearrange into a straightened configuration:



Retinal molecule $C_{20}H_{28}O$ photon-mediated conformational change

This basic model, in which a molecule is forced to react, i.e. moves dynamically, to a photon or field particle stimulus, is the basic model (poster child) for human molecular life, i.e. for all human behavior. The human molecule, a 26-element molecule, is no different than the retinal molecule, a 3-element molecule. Human chemical reactions will always be exact and repetitive, similar to the bending and straightening actions of the simple retinal molecule. More to the point, the central nervous system of the retinal molecule is no different, complexity aside, than the central nervous system of the human molecule: each CNS is comprised, at its core, of valence shell electron-photon interactions. One should always refer back to this basic molecular model in human chemistry. The chocolate eating scene in the second *Matrix* film captures this dynamic perspective brilliantly.

In the retina of the eye, the dynamics related to the straightening of the retinal molecule, in turn, affects a neighboring protein molecule called opsin, which results in the generation of an information-carrying nerve impulse.[45] Retinal molecules are found in rod cells embedded in the retina of the eye, each of which typically contains some two-thousand stacked disks. Each disk is studded with approximately one-hundred-million rhodopsin molecules.[46] Each rhodopsin molecule contains two parts, the opsin protein and the retinal molecule. These three components, photons, opsin, and retinal interact in ways that functions to convert visual information in neurological behaviors. Again, high-end estimates indicate that perhaps near to eighty percent of our total sensory inputs are visual.[28]

Along these lines, knowing that the energetic photon is a carrier of the electromagnetic force, and knowing that approximately five photons are required to trigger a nerve impulse, the obvious fact should be highlighted here that sensory inputs are, in effect, *driving forces* that function or actuate to compel organisms in certain reactive directions.[15] In simple terms, the electromagnetic force operates via the exchange of field particles called photons. In the ocular sense, five photons

are required to trigger a nerve impulse. Triggered nerve impulses result in 'forced' conscious action. The great Scottish physicist James Clerk Maxwell, the founder of electromagnetic theory, was the first to note this fact when, in 1847, at the age of seventeen he stated:[47]

> "The only thing which can be directly perceived by the senses is a force."

Maxwell, of course, was well ahead of himself. According to current views, it is now known that all human receptor or sensor inputs are triggered into action via forced photon-electron interactions in the periphery outer-shell atomic electron structure of the human. The sensor inputs 'force' a central nervous system response. These quantum electromagnetically-driven responses, as the Austrian psychologist Sigmund Freud showed, may lie dormant for period of a person's life, or even may exist as 'unconscious forces', but they are always forces, and there will always be a reactive response.[48] Moreover, in the words of sense researcher Diane Ackerman:[49]

> "Our senses define the edge of consciousness."

Together, Ackerman and Maxwell's logic combined clearly illuminate the reality that consciousness is a forced entity. In other words, basic human consciousness is no different that the rudimentary type of quantum consciousness found in the retinal molecule.

In the human molecular case, all sensor inputs are received or processed by what are called supramolecular receptors found both peripherally and within the human organism, otherwise known as sensory organs.[50] *Sensory organs* are structures of the peripheral nervous system that convert physical or chemical stimuli into signals that are sent to the central nervous system for processing and interpretation.[51] All living organisms contain biological sensors.

Biological sensors are specialized cells that are sensitive to inputs of both the internal and external physical environment. External environmental stimuli include light, motion, temperature, magnetic fields, gravity, humidity, vibration, pressure, electrical fields, or sound, etc. Internal environmental stimuli include glucose level, oxygen level, osmolality, stretch, motion, and position of appendages, etc. Sensors also respond to an enormous array of environmental molecules, including toxins, nutrients, and pheromones as well as an equally varied range of internal signal molecules, such as hormones, neurotransmitters, and cytokines. Moreover, sensors register differences between proteins of the organism itself and of the environment or foreign substances.[52]

Supramolecular receptors come in five basic configurations: *mechanosensors*, which respond to mechanical forces; *thermosensors*, which respond to temperature changes; *electrosensors*, which respond to voltage gradients, *chemosensors*, which respond to molecular structures; and *photosensors*, which respond to light. Photosensors, found in the retina of the eye, have the same basic membrane structure as chemosensors, as previously diagramed, except that a retinal molecule is found where the receptor protein would be. Electrosensors operated by opening an ion channel, i.e. a porthole that selectively allows certain charged elements through, in the sensor membrane structure whenever a voltage gradient is present. In thermosensors, the same basic principle applies, only that there is a heat-sensitive enzyme adjacent to the ion channel, which causes it to open or close based on warmth. With mechanosensors, pressure-sensitive ion channels in the membrane structure mediate the flow of ions.

In general, receptor sensors function by processing a membrane protein that detects a stimulus and responds by altering the flow of ions across the cell membrane. The resulting change in membrane voltage potential causes the sensor either to fire action potentials itself or to secrete neurotransmitters into an associated cell that fires action potentials.[51]

Of the bodies' numerous sensory structures or molecular receptors, such as the eyes (photoreceptors), ears (auditory receptors), nose (olfactory receptors), tongue (gustatory receptors), balance (proprioceptors), touch (somatosensory receptors), thoughts (neuronal sensors), etc., it is known that each of these molecular information receivers is intricately adapted to deal with its own type of stimulus which come in one of three varieties: waves, e.g. light waves, vibrations, e.g. sound waves, or molecules, e.g. olfactory molecules.[52]

In finite atomic detail, each of these varieties of human-receptor external-world stimulus interactions reduces to a series of quantum electrodynamic interactions in which photons transmit the electromagnetic force to outershell electrons found in the external orbitals of human supramolecular receptors.[15] In addition, each receptor, being quantum electrodynamic in operation, does essentially the same job: it translates its particular type of stimulus into electrical impulses. All sensory stimuli, then, enter the brain in more or less undifferentiated form as a stream of electrical impulses created by neurons firing, domino-fashion, along a certain route.[53]

These electrical inputs then function to trigger the voltage potentials stored in sets or networks of nerve cells, which can be thought of as *neurological transistors*, i.e. electronic devices that are used to control the flow of electricity. Resultantly, an out-going stream of information-packed electrical impulses are generated in the human peripheral nervous system resulting in an either an immediate dynamic reactionary state of action in proportion to the set of inputs or a stored yet indeterminate reaction yet to be realized.[54] Because of this configuration, not all field particle inputs result immediately in action, some lie dormant for periods in a state of

either indifference or ambivalence. These sensory interactions and the neurological processing associated with them constitute the underlying atomic details involved in the mechanism of all human bonding interactions. All bonds are regarded as involving only electrons from the outer energy level of those atoms taking part in the bonding process.[55]

Building on this logic, those structures, bigger in size than photons, exchanged between human molecules, entities such as a word verbally spoken, i.e. vibrations of wave-groups of air molecules, or a pheromone, i.e. a molecular structure, or currency, i.e. numerous molecular structures of value such as a quantity of gold, or information, e.g. a book borrowed, or emotion, i.e. combinations or packets sensory indicators, etc., can all be though of as 'secondary' force particles. The equivalent of only thirty molecules, which, as a bound state entity, can be thought of as a force particle, of the female sex attractant, for example, will excite the male cockroach and make him raise his wings and attempt to copulate.[56]

We base this secondary force particle argument on high-energy particle physics studies. In physics, it is well known that smaller forces have the tendency to coalesce into packets of larger forces at higher energies. This line of reasoning is what is called the *grand unification theory*. Physicists, thus far, have been able to merge the electromagnetic force and the weak nuclear force together into the electroweak force; and experimentation is presently underway to merge electroweak force and quantum chromodynamics into a quantum chromodynamic-electroweak interaction. Beyond grand unification, there is also speculation that it may be possible to merge the force of gravity with the other three gauge symmetries, i.e. forces, into a theory of everything.[57]

Hence, with respect to human interactions and their intermediary forces, i.e. messenger particles (force carriers), that mediate or carry these interactions, we will use, in an approximate manner, a primary and secondary classification scheme in which direct photon exchange is considered a primary field particle, e.g. one photon, and all other exchanges are mediated or transmitted via secondary field particles, e.g. a quantity of five photons:

Primary field particles – gauge bosons, i.e. gluons, photons, W and Z bosons, and gravitons, that act as force carriers.

Secondary field particles – coalesced or grouped particles, e.g. five photons, thirty molecules, pheromones, information, currency, emotion, etc., that act as *effective* force carriers.

To elaborate, in exacting detail, primary field particles are the key players or movers in the dynamics of universe. One proton, for instance, is a structure comprised of two up quarks and one down quark and the exchange of gluons between the three quarks is what constitutes the action of the strong nuclear force. Subsequently, one

gluon will have an 'effect' on the behavior of one quark. In the human molecular case, however, one photon, in many situations, will *not* have an effect on the behavior of one human molecule. In the ocular sense, being the simplest example, five photons are needed to trigger a response in the recipient, e.g. a nerve impulse. Thus, for simplification purposes, the energy contained in the set of five photons, when viewed as one bulk messenger particle, can be thought of as a coalesced field particle, which in human chemistry will be defined as a 'secondary' force.

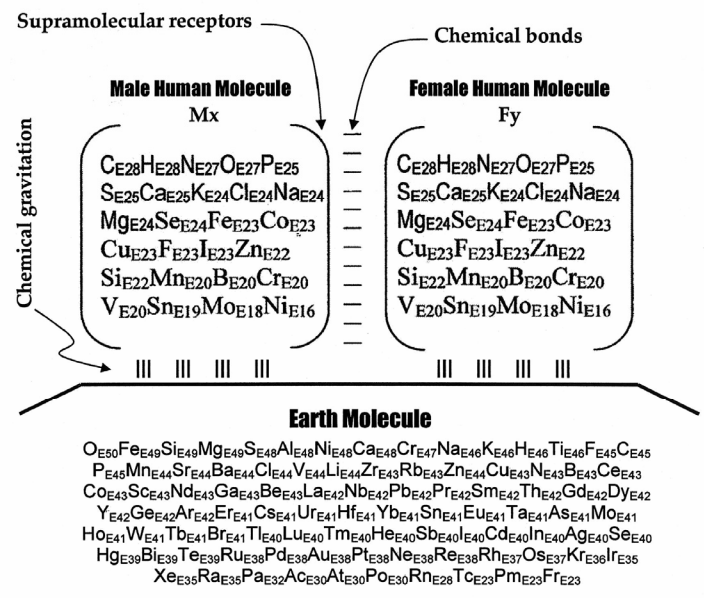
In each case, an entity that acts as a messenger particle, in which it functions to change the character of the particles (entities) that swap or transmit them, will mediate the effect of the bulk force. In simple terms, as an example, it is well known that money carries force, whereby an amount of money, e.g. a pound of gold, is a quantity of atoms. That is, to ask someone politely to do an arbitrary task, the request may or may not follow through into action. Conversely, if one pays a large some of money in request to do some trivial task, there is a high probability that the task will be 'forced' into actuation.

Neurologically, as mentioned, it is known that it takes a minimum of five visually received photons to trigger a nerve impulse. Similarly, for example, we might reason that it takes a minimum amount of currency reception to trigger the appropriate channels of financially-related nerve impulses, which are connected to information-laden neuron voltage potentials, to trigger a correlative desired dynamic result. Children will know, for example, that it takes a minimum currency reception of about twenty-dollars to convince any random child to eat a bug on a dare. Hence, a twenty-dollar bill can be thought of as a *secondary field particle*, i.e. a structure that transmits a force.

Thus, in human life such entities as sound waves, pheromones, scent molecules, emotion, information, money, gifts, etc., can all be though of as either primary or secondary field particles. To clarify, when two people, for example, a husband and a wife, exchange glances and are visually stimulated, the messenger particles involved are photons, i.e. primary field particles, directly exchanged. Yet, when two people, for example, a commuter and a gas station attendant, exchange physical quantities, such as gas for money, the messenger particles involved are secondary field particles or molecular structures, predominately, e.g. a dollar bill exchanged for quantity of gas. In all cases, however, the underlying dynamics of these exchange processes are driven by the effect of photon-electron interactions at the quantum electrodynamic level; some exchanges are just more complicated and tedious to describe than others.

Human beings, as explained, are large twenty-six-element molecules, which for the purposes of this discussion are defined as matter particles, symbolized by dots ●, and these dynamic structures interact with others similar dynamic structures by exchanging photons directly or by exchanging molecular quantities mediated by photons indirectly. In addition, interpersonal exchanges mediate through what are called supramolecular receptors. These basic and essential definitions are detailed

below, which shows two human molecules, each in possession of a unique molecular formula, chemically attached to each other and also attached to the earth molecule, in the form of a type of chemical-gravitation:



In short, humans exchange quantities and these exchanges, rather then just pushing particles or bodies apart, instead function to change the 'character' or resultant behavior of the particles or bodies that swap them. This change in behavior actuates to keep such 'linked' bodies in mutual association, over set timeframes, as though there was an apparent force in existence.[58] This description is the basic definition of the exchange force.[59] These basic definitions from physics apply in all respects in human life. In 2005, for example, Russian physical chemist Georgi Gladyshev, a pioneer in the field of human thermodynamics, stated as matter of fact that:[50]

> "The correlation between the interaction of supra-molecular receptors, e.g. receptors of light, smell, sound, electromagnetic fields, gravitational fields, etc., and the interaction of people can be obtained."

All dynamic bonding interactions in the universe operate according to these principles; any type of fundamental exchange or interaction, underlyingly, is one of the four fundamental forces at work. In human life, force particle absorptions, exchanges, and emissions function through the interactions of one or more of the dozen or so receptors or senses of human perception as connected neurologically to the main switchboard: the central nervous system.

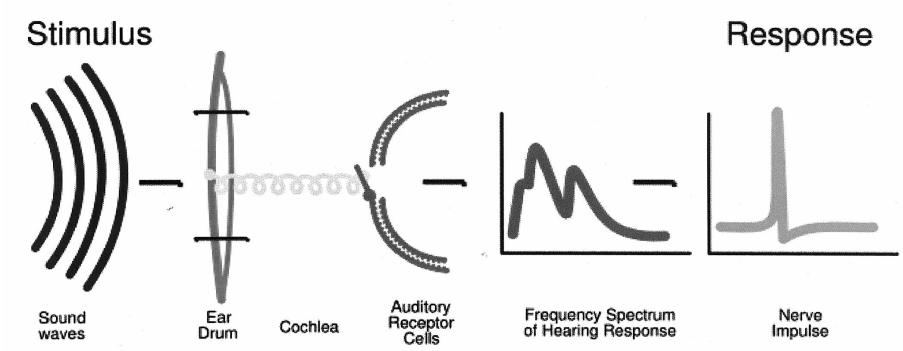
As complicated as these multifarious human interactions may at first seem, if we neglect gravitational and radioactive phenomena, all human sensory perceptions boil down to the simple interactions of photons with electrons, i.e. the interactions between outershell electrons of human supramolecular receptors with the photons in the surrounding environment. Any type of inter-human bonding can be traced to interactions of photons with electrons. These exchanges include, predominately, photons γ, e.g. visually seeing something, biophotons γ, e.g. photons released from biological structures, exchanges of scent molecules, e.g. pheromones, information exchange, e.g. talking which accrues to the affect of pressure variations in airwaves, or man-made molecular structure exchanges which occur via photonic actions indirectly, e.g. handing someone currency, etc. This of course, as we see, is an immense topic.

To clarify further, in terms of vocal exchanges, say $\bullet_1$ is a woman at a bar who yells to second woman $\bullet_2$, the utterance 'F**k you b***h'. After the first women releases this comment, or force-carrying particle, her central nervous system might compel her to walk away, a sort of recoil effect. The second woman, after hearing this negative comment, we might reason, may also feel the need to leave, as the comment would have been perceived as 'repulsive' rather than 'attractive'.

To transmit this message, pressure variations of adjacent air molecules would have carried this information from the vocal cords of the first woman to the eardrum of the second women. From here, information-laden nerve impulses would have been triggered thus compelling the women, either consciously or unconsciously, to respond accordingly. At the atomic-level of discernment, however, during each step in this mechanism, photon-exchange would have been at work. Photon exchange, again, is what results in the electromagnetic force. To clarify, *sound,* e.g. from a speaker, can be defined for our purposes as a longitudinal wave created by vibrating air-molecules. The electrically operated diaphragm of the speaker serves as a good representative model for the human voice.

In a speaker, to create sound waves, first the diaphragm of the speaker moves outward causing the air molecules directly in front of it to compress into a region of high pressure called *condensation*. This region of high pressure begins to move through the crowd of air molecules—similar to how people do the 'wave' around a football stadium—the people don't move around the stadium—but the wave does. Subsequently, within a matter of microseconds the high-pressure air region moves forward leaving in its midst a region of low pressure called *rarefaction*.

Through this process of condensations and rarefactions, sound waves are created which travel from the speaker to the listener. Again, the individual air molecules do not move with the wave, only the variations in pressure do. Loosely speaking, each air molecule vibrates back and forth about a fixed location; the more it vibrates, the greater the pressure; the greater the pressure, the more each molecule collides with its neighbor and in doing so passes forward condensations and rarefactions:



At the atomic level, this vibration is a result of photons γ exchanging between outershell electrons within the atomic orbitals of adjacent air molecules. Generally, as mentioned, atoms release photons γ when they stabilize, and absorb photons when destabilizing. The more unstable or energetic an atom or molecule becomes the more it vibrates. When variations in vibratory-intensity coming from a speaker or someone's voice reach another person's eardrum, the information content contained in the vibration rate of the wave is interpreted by the brain as sound.[60]

Thus, if we hear someone with an agreeable personality, we will be compelled towards that person. If someone at a party, for example, tells an interesting story, people move closer. In this case, vibratory motion of air-molecules, owing to photon γ exchange between the neighboring air molecules, create ocean-like waves of pressure variations, thus causing specific molecules of the tympanic membrane of the outer eardrum to vibrate accordingly. This vibration moves three bones within the ear: the hammer, the anvil, and the stirrup—the three smallest bones in the body. These bones press fluid in the inner ear against membranes, which brush tiny hairs that trigger nearby nerve cells, which telegraph messages to the brain as sound. Auditory information, as mentioned, accounts for about 24 percent of total our daily sensory inputs.

The third most dominate sense is touch, which accounts for nearly nineteen percent of our total sensory package. The integumentary system, i.e. skin, is where the mechanosensors, which mediate the sense of touch, are located. Even a small patch of skin contains a diversity of sensors that send information to the brain. Skin accounts for sixteen percent of our body weight and is the largest organ in the human body.[49] Mechanosensors called *Meissner's corpuscles* respond to subtle or soft touches, but also adapt very rapidly. In the outer portion of the skin are expanded-tip tactile sensors of various kinds, which adapt only partially and slowly, and as such they provide information about objects that continue to touch the skin.[61]

Deep within the skin are mechanosensors called *Pacinian corpuscles*, which respond to vibrations, but adapt rapidly to steady pressures. Lastly, neuronal extensions wrap around each hair follicle on the body providing information about subtle quantities such as wind direction, gentle brushes, insect attachments, etc. One

of the functions of touch is to facilitate the discernment of human molecular contacts via transmission of chemical information. Certain types of pheromones, for example, are proteins that must be transferred directly by skin-to-skin contact, such as by kissing.[62] In this perspective, kissing is a form of pheromone *ID swapping*. When a mother kisses her baby, for example, she increases the effect of parent-infant bonding.[63]

Touch, interestingly, has been an area of recent investigation. Massaged babies, for instance, gain weight as much as fifty percent faster than unmassaged babies.[49] Tactile interactions between a mother and child, such as suckling, or between a romantic pair, such as cuddling, are known to release the neurochemical oxytocin, which facilitates the bonding process.[64] Moreover, when someone we like touches us, it causes the body to secrete endorphins, the body's natural opiates.[65]

The funniest touch experiment occurred at Purdue University Library. In this experiment, a women librarian was instructed to brush a student's hand lightly and as insignificantly as possible, as she returns their library card. She did this to fifty percent of the students. When the students left the library, they were instructed to fill out a questionnaire about the library in general. By the end of the day, the pattern became clear that, although no students reported being touched, those students who had been subconsciously touched reported more satisfaction with the library and life in general.[49]

The sense of smell is the fourth most dominate information collector, accounting for approximately twelve percent of our daily information quota. Each day, we breathe about 23,040 times and move around 438 cubic feet of air. It takes five seconds to breath, two seconds to exhale, and in that time molecules of information carrying odor flood through our human molecular system.[49] Humans can recognize approximately 10,000 scents via approximately 1,000 receptors. We need only eight molecules of a substance to trigger a nerve impulse, but forty nerve endings must be aroused before we can actually smell something.

One of the most studied scent molecules is human testosterone. Because animal musk is similar to testosterone, humans can smell it in portions of as little as thirty-two femto-ounces. Testosterone, interestingly, was first isolated from a bull in 1935.[66] In women, testosterone is found to facilitate pregnancy. In one experiment conducted at the *International Flavors and Fragrances Institute*, women who sniffed musk developed shorter menstrual cycles, ovulated more often, and found it easier to conceive. To summarize the intimate relationship between the process of human bonding and scents, in the words of Auguste Galopin author of *The Perfume of Women and the Sense of Smell in Love*:

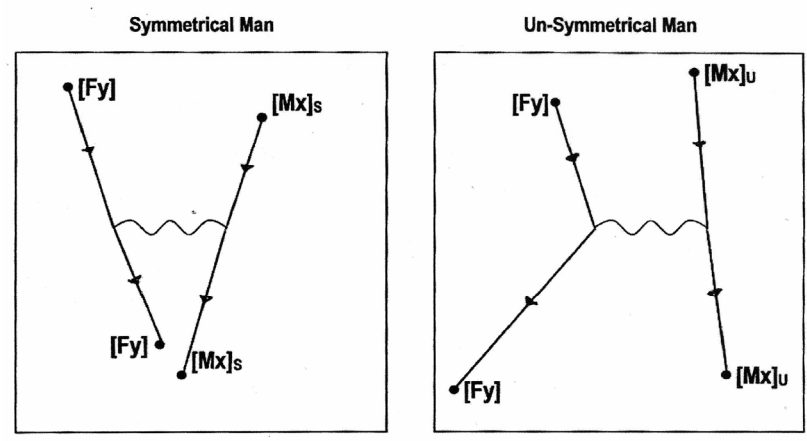
> "The purest union that can exist between a man and a woman is that created by the sense of smell."

In recent years, the definition of pheromones has been expanded to include both attractive types and repulsive types, both of which play a major role in the bonding between persons. Bonds will only hold when there is an overbalance of attraction to repulsion, at about a 5-to-1 ratio, i.e. the *Gottman ratio*. While you may be attracted to the pheromones of one person, those of another person may repel you.[67]

As a third example, if we smell someone with an *un*-appealing scent, we will be inclined to unconsciously move *away* from this person. Here, diffusional movements, i.e. spontaneous movement of particles owing to thermal agitations and concentration gradients, of volatile sent molecules, such as estrogen, testosterone or steroid-like pheromone molecules, through the air, due atomically to inter-molecule photon-electron exchange, reach olfactory receptor sites in the nasal cavity. This causes those connected nerve cells to trigger appropriately depending upon the type of scent molecule.

As an example, it is well known that people can 'smell' asymmetry, such as a crocked face, a lopsided body, or a hunched back, etc., in potential mates—without ever seeing the person. If, for example, three sweaty men are put in separate ventilated rooms, and any woman, in her estrus phase, around the twelfth day of her menstrual-cycle, but not on the pill, is asked to smell the vents of each room and to report as to which vent she is most repulsed by or most attracted to—she will be most repulsed, a change in velocity and direction away from sender, by the smell of the more asymmetric man's vent, and most attracted, a change in velocity and direction towards from sender, to the more symmetrical man's vent.[68] Using Feynman diagrams, as shown below, we can clarify this description further.

Suppose, for example, that a woman [Fy] passes two men: a symmetrical man $[Mx]_S$, and an unsymmetrical man $[Mx]_U$. Regarding scent alone, with relation to only symmetry, Feynman diagrams would define the resultant interactions via *particle exchange*. In the left Feynman diagram, we see a change in the female's velocity and direction towards the symmetrical man; in the right Feynman diagram, the female is repelled away from the asymmetrical man. In this type of situation the mediator particle would be, superficially, a scent molecule—yet at the point of contact, i.e. the cilia protein receptor site, the exchange would be of a photon γ variety, and the force working to hold the scent molecule to the protein receptor would be electromagnetic:



In this manner, exchanges result to both repel us and to attract us to the people we associate with; the exchanges between those whom we like or prefer, actuate continuous behavioral changes such that there is a favorable dynamic balance of attraction to repulsion that holds us in relative proximity to them. Exchanges with those for whom we are naturally disinclined towards, tends to actuate behavioral changes such that repulsion tends to predominate.

Human molecular spin

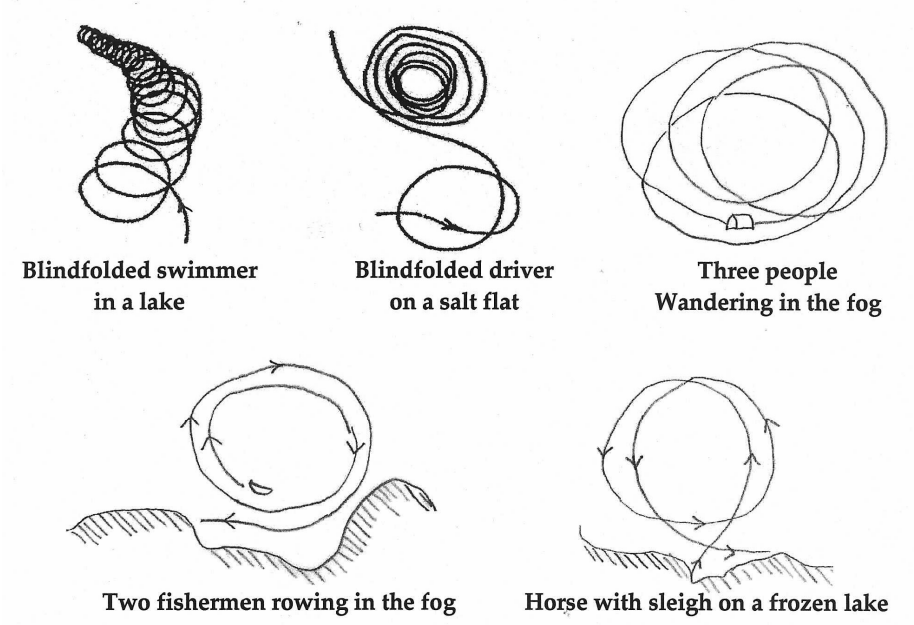
To compound the issue of field particle exchanges between individual humans, there is the issue of field particle exchanges between the earth and humans, i.e. between the earth molecule and individual human molecules attached to its surface. In short, whenever a charge moves, it creates a magnetic field that curls around the axis of its trajectory and when an external magnetic field is applied to a charge it causes the charge to curl in motion around the axis of the magnetic field.[69]

When this principle is applied to human life, the general effect is to cause human molecule to rotate differently depending on whether they are located north or south of the equator. At the North Pole, the earth's magnetic field lines go into the ground; at the South Pole, the field lines come out of the ground. As a result of this, people tend to drive on the left hand side of the road in the southern portion of the earth and on the right side of the road in the northern portion. When Feynman diagrams are used to represent human molecular interactions, subsequently, a spin or curl pattern will develop within each system of interaction.

In a general manner, all structures in the universe, according to similar types of arguments, rotate, spin, or move along circular paths. Human molecules, likewise, have a characteristic *spin*. In physics, spin is the intrinsic angular momentum of a subatomic particle, nucleus, atom, or molecule that continues to exist even when a particle comes to rest.[34]

In simpler terms, each human molecule has a specific tendency to more in a curved or circular-patterned type motion within its movement daily activity orbitials depending upon whether its location is north or south of the equator in respect to the earth's magnetic field. People have the tendency, as noted, to drive on the right side of the road north of the equator, e.g. in America, and on the left side of the road south of the equator, e.g. Australia. Similarly, as is famously depicted in horror movies, if a person gets lost in the woods and tries to walk in a straight line, the person will strangely return to the starting point, because in reality, they have walked in a circle.

These spin or rotation tendencies result owing to a combination of the effect of earth's magnetic field and spin of the nuclei and electrons of the atoms that comprise the earth. The details underlying spin, in the universe, are immensely complicated. If movement patterns are tracked at the workplace, however, over the course of a day, it is found that people tend to feel comfortable moving clockwise, if they work north of the equator, and counter-clockwise, if they work south of the equator. Other examples of *molecular spin* are shown below. The approximate circles shown of the three people wandering, the two fishermen rowing, and the horse example all have circumferences of approximately 2.5 miles:[70]



Blindfolded swimmer in a lake

Blindfolded driver on a salt flat

Three people Wandering in the fog

Two fishermen rowing in the fog

Horse with sleigh on a frozen lake

To summarize, each human molecule has a characteristic spin; generally defined as the intrinsic angular momentum about its own center of mass that continues to exist even when a bound state particle comes to rest. Said another way, each human molecule has a specific circular-patterned motion within its molecular orbitals depending upon whether the molecule is location north or south of the equator in

respect to the direction of earth's magnetic field lines according to the right hand rule as dictated via Maxwell's field equations.[69] The first to note this human spin phenomenon was Ernst Mach, the Austrian physicist and philosopher known for the namesake *Mach number* or Mach speed. Mach labeled this strange human spin characteristic as 'turning tendencies'; in 1885 he wrote:

> "Learned from a retired army officer that on dark nights or in snow-storms...troops will move approximately in a circle...so that they almost return to their point of departure, though all the time they are under the impression that they are moving forward."

With Feynman diagrams, we are able to use *vector notation* to characterize and to quantify the movement dynamics of each such human point-mass. The motion of the human point-mass, signified by vector arrows, having both a magnitude and direction, however, is not perfect. One detail, to clarify, as we have shown, is that in bound state resolution, object paths are always curved or curled. The way in which the fundamental forces of the universe interact with bodies of matter is to curl their motion.

Normally, however, we do not notice the curved nature of our movements. In human life, structural formations such as expressway lanes, hallways, sidewalks, trails, etc., function as *waveguides*. That is, via sensory feedback, in the form of information transmitted or reflected in waveform, human paths are guided along straightened paths, relatively speaking. Even within waveguides, however, human motion still has a slight sinusoidal nature to it, e.g. when walking down a hallway one will tend to oscillate from side to side. This is a cousin-phenomenon to what is commonly known as 'wave-particle duality', e.g. Bucky balls, which are large carbon molecules comprised of sixty carbon atoms, move like waves and particles, simultaneously.

In the chapters to follow, we will continue to build on these perspectives by introducing German physicist Max Planck's theory of quantum energy emissions and how this led to the development of human molecular orbitals.

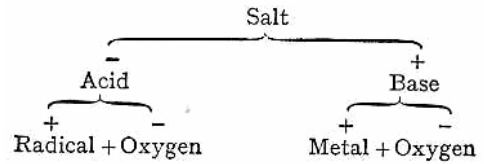
8 – Planck's Quantum:

"The existence of life must be considered as an elementary fact that can not be explained, but must be taken as a starting point in biology, in a similar way as the *quantum of action*, which appears as an irrational element from the viewpoint of classical mechanical physics, taken together with the existence of elementary particles, forms the foundation of atomic physics."

Niels Bohr, 'Light and Nature', *Nature* - 1933

Human molecules, from an accelerated spatio-temporal (space-time) Feynman diagram perspective, are bound-state atomic entities, dormant by night, reactive by day, that effect each other's life movements through exchange forces.[1] In short, diurnally, reactive human molecules exchange field particles mutually and it is the reception and transmission of these *primary* (photons) and *secondary* (quantities) 'exchanges' that directly guides or forces the movement of human particles in daily activity or movement 'orbitals', which, like all molecular orbitals, are probabilistic.[2] Moreover, whenever two or more human molecules interact such that their orbitals overlap favorably or synergistically, in such a manner that the internal energy of the joint system is lowered, a bonding effect actuates.[3]

An atomic or molecular orbital, by definition, is an electron probability region.[4] Historically, the basic theory of molecular orbitals, traces its origins to a postulate of energy quantums in nature and before that to the discovery of charge distributions in atoms, namely that atoms have positively-charged centers surrounded by negatively-charged electrons. The first semi-accurate model to account for charge distributions in molecules was proposed by Swedish physician and chemist Jöns Berzelius, in which a salt has the following chemical-electronic structure:[5]



Berzelius' 1831 charge distribution model

In this model, brackets are used to signify a chemical bond or association. Several discoveries and inventions led to the development of this model. In 1776, Italian physician and physicist Luigi Galvani noted the twitching in the muscles of frog legs suspended by copper hooks on an iron rail. Galvani found that when one metal was put in contact with a frog's nerve and the other in contact with a muscle, such to form an arc, a contraction would occur owing to the flow of electric current. In 1800, based Galvani's findings, Italian physicist Alessandro Volta invented the electric battery, called the *Voltaic pile*.[6] Soon chemists began using the power of this new tool to break apart the chemical bonds in molecular fluid systems, a technique called *electrolysis*.[7] Using electrolysis, chemists were thus able to separate bonded elements and compounds by passing an electric current through them, thereby giving a clue as to the basics of molecular structure.

During these revolutionary years, in 1807, Berzelius had become a chemistry professor at the Karolinska Institute, one of the largest medical schools in the world. Over the next several years, he wrote a chemistry textbook for medical students and in 1831 after studying the results of various electrolysis experiments he outlined an electrochemical theory in which a salt has an atomic structure composed of an acid, with a negative charge, and a base, with a positive charge.[8] The acid and the base were further deduced to that of an acid anhydride, comprised of a positively charged radical attached to a negative oxygen, and a basic oxide, comprised of positive metal attached to a negative oxygen.

Molecules, according to this view, are three-dimensional structures comprised of positive and negative charges attached, in some way, to their structure. Berzelius' charge distribution model was based on the observation that salts in solution are decomposed by the electric current of a Voltaic pile into bases, which attract towards the battery's negative pole and therefore seem to carry a positive charge, and acids, which are drawn to the battery's positive pole and therefore seem to carry a negative charge.[8]

In 1852, English chemist Edward Frankland developed a revolutionary theory of chemical valence, or degree of combining power in an element. In short, Frankland combined the older theories of *free radicals*, i.e. attachment preferences for chemical species with unpaired electrons, and *type theory*, i.e. a theory by which the properties of compounds are determined by their 'type', e.g. the ammonia type, with thoughts on *chemical affinity*, in which certain species combine with other species according to specific affinities or attachment preferences, to show that certain elements have the tendency to combine with a specific number of other elements.

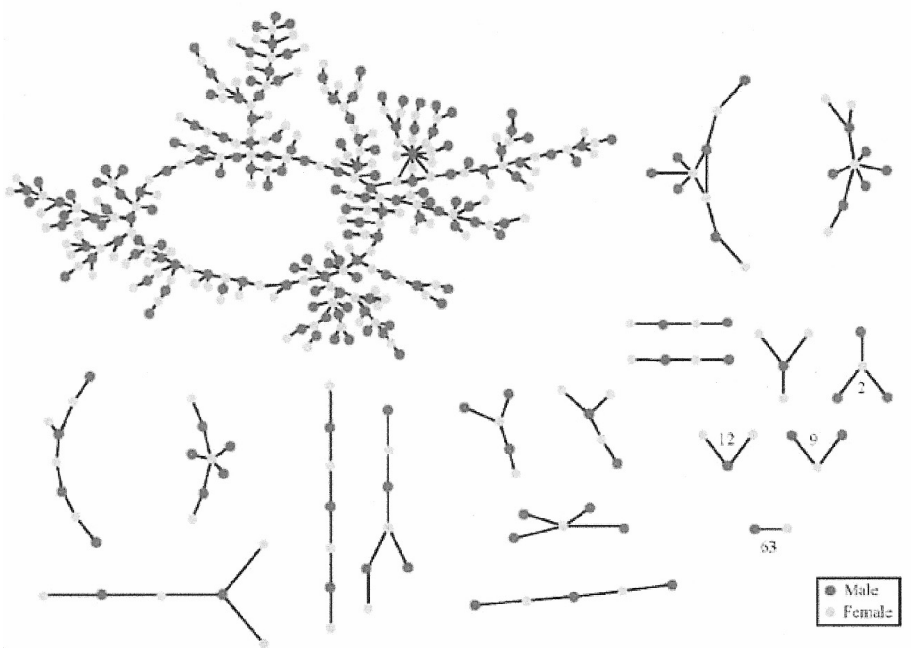
Certain elements, for example, might prefer to form compounds containing 3 bonded units, i.e. in the three atom groups (e.g. NO_3, NH_3, NI_3, etc.) or 5, i.e. in the five atom groups (e.g. NO_5, NH_4O, PO_5, etc.), equivalents of the attached elements.[9] It is in this manner, according to Franklin, that their chemical affinities, or inherent

predispositions towards attachment, are best satisfied. Following these examples and postulates, Franklin declared how obvious it is that:[10]

> "A tendency or law prevails (here), and that, no matter what the characters of the uniting atoms may be, the *combining power* of the attracting element, if I may be allowed the term, is always satisfied by the same number of these atoms."

This 'combining power' was afterwards called quantivalence or valency and *valence* by American chemists.[8] In the early 20th century, this evolved into various quantum-based valence bond theories.

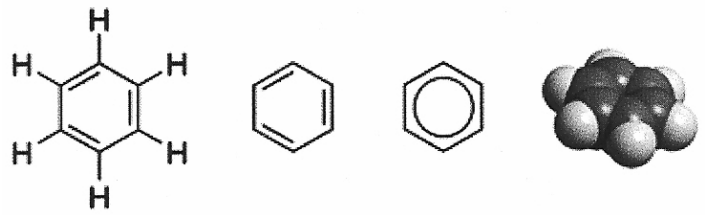
In human chemistry, similarly, each category, specific type, or patterned human molecule has different powers of combination or valency.[11] In 1995, for example, American sociologists Peter Bearman, James Moody, and Katherine Stovel mapped the sexual attachments and resultant human molecular formations of 832 students at a U.S. mid-western public high school with a population of about 1,000 students.[12] A diagram of their results is shown below:



In this diagram, each nodal point is one human molecule and the ties between each node are genetic-potential sexual chemical bonds, in which there occurred some type of fluid exchange. Specifically, the diagram is a result of a survey in which students

were asked to identify their sexual and romantic partners in the past 18 months from a roster of students attending the school.[13]

Interestingly, aside from many two-, three-, and four-chain human molecular complexes, approximately ½ of sexually active population, 573 students, had assembled into a ring-shaped, 288-person, $Mx_{144}Fy_{144}$, sexual social cluster, as shown above, having many side chains. This large hecta-human molecular sexual relationship ring is similar in basic stability tendencies to that of the simple 6-chain benzene C_6H_6 ring:



Atomic structure of the benzene C_6H_6 ring.

The people in these side chain branches were kept 'in the loop', as they say, through key people who functioned as 'connectors' to the main chain. To explain this loop cluster pattern, researchers noted that person *A* had relations with person *B*, who had relations with person *C*, and so on, such that the relations were all inter-connected. In this main sexual ring, the two most distant people were connected by thirty-seven degrees of separation.[14]

Other *di-*, *tri-*, *tetra-*, *penta-*, *hexa-*, or *hepta*-human molecular structures and their relative abundances are shown. In particular, there were 63 *MxFy* pair bonds, 12 $MxFy_2$ male-centric molecular species, 9 Mx_2Fy female-centric molecular species, and 2 Mx_3Fy female-centric molecular species. In the Mx_3Fy case, for example, the molecular structure, in a technically manner, is a tetra-humanide molecule comprised of one female and three males, in which the central female, called the 'core' species or nodal molecule, is trivalent in her sexual relationship bonding tendencies. In sum, different humans have different combining powers or valencies.

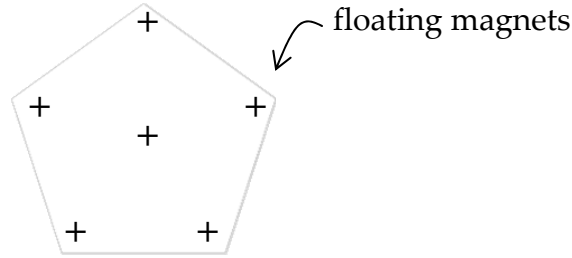
In 1874, using Berzelius' charge distribution theory as a basis, Irish physicist George Stoney, in a paper entitled 'On the Physical Units of Nature', postulated that in nature there exist fundamental units or quantities of electricity, which are independent of any particular body, and that exchanges of these electrical units account for chemical bonds:[15]

> "For each chemical bond which is ruptured within an electrolyte a certain *quantity of electricity* traverses the electrolyte which is the same in all cases."

Moreover, in 1891 Stoney famously coined the term *electron* for the fundamental unit of negative electricity, as based on the Greek word for amber, *electron*, which itself was introduced earlier by English physician William Gilbert, as mentioned, who in his 1600 book *De Magnete* had outlined the results of his studies of the static electricity produced by amber.[16] In addition, Stoney stated quite accurately that the motions in each atom or molecule cause electrons to be 'waved about' in the body of the atom and that in this constrained electron motion the distinctive spectrum of each kind of gas originates. In other words, the frequencies of the electromagnetic waves emitted or absorbed by the atoms of the gas are due to the movement of the electrons in the atom.

On these views, in 1878, in efforts to discern a possible theoretical basis for molecular structure, American physicist Alfred Mayer performed his famous floating magnet experiment.[17] Specifically, Mayer took an assorted number of magnetized needles and stuck them through corks, floating in water, such that their *north poles*, i.e. positive ends, were all facing upwards at the same height above the water, all repelling each other equally. Mayer then held the *south pole* or negative end of a more powerful magnet some distance above the surface of the water to attract the needles simultaneously towards this center. The idea was to see what geometric equilibrium stability patterns formed for different numbers of needles under the influence of the similar attraction for the opposite pole as this attraction conflicted with the effects of mutual inter-magnet repulsion between the like (negative) poles.

Mayer found an interesting pattern: the like negative-poled needles liked to arrange themselves into concentric rings of stability. Three magnets formed a triangle, four a square, and a five a pentagon. When six magnets were used, however, one went to the center leaving the others to form a ringed pentagon:



With eight magnets, two went to the center and six remained in an outer ring. As more magnets were added, up to eighteen, a separate inner system formed distinct from that of an outer ringed system. Beyond this, three systems formed an inner system, a middle ring, and an outer ring; and for a still larger number of magnets a four system ring pattern would emerge, and so on.

To explain these curious equilibrium stability patterns, Mayer reasoned that the competing attracting and repulsing tendencies, between the like poles and oppositely charged central pole, respectively, resulted in the formation of geometric stability

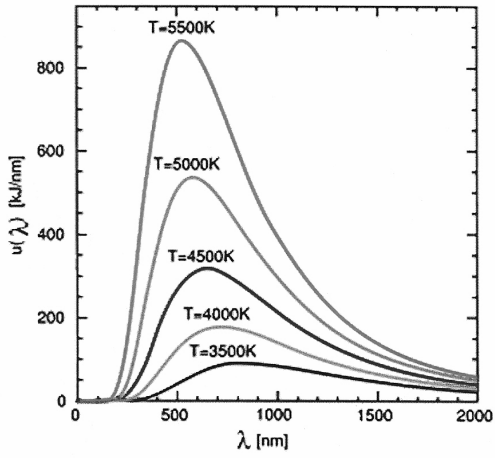
patterns, according to which the size of each pattern was determined by the relative strengths of the individual attractions and repulsions. The number of magnets, subsequently, determined the different stability patterns, in which each arrangement was the result of a local minimum energy configuration. This magnet model would later be used in the construction of early models of the structure of the atom.

In 1897, after investigating the behavior of cathode rays in relation to changes in externally-applied electric and magnetic fields, British physicist Joseph Thomson experimentally discovered Stoney's hypothetical electron. Later, in 1904, using Mayer's floating magnet results as a basis, Thomson proposed an atomic model in which *n* negatively electrified particles, moving in a uniformly electrified positive sphere, would tend to arrange themselves into a series of concentric *shells*.[18]

Connected to this, is the mysterious *black body problem*, a problem that was originally stated in 1859 by German physicist Gustav Kirchhoff. In physics, a 'black body', a term introduced by Kirchhoff in 1860, is an object that absorbs all electromagnetic radiation that falls onto it. No radiation passes through it and none is reflected. It is this lack of both transmission and reflection to which the name refers. These properties make black bodies ideal sources of thermal radiation. That is, the amount and wavelength (color) of electromagnetic radiation they emit is directly related to their temperature. Black bodies below 700 K produce very little radiation at visible wavelengths and appear black (hence the name). Black bodies above this temperature, however, produce radiation at visible wavelengths starting at red, going through orange, yellow, and white before ending up at blue as the temperature increases. The light emitted by a black body is called *black-body radiation* (or cavity radiation).

The problem involved finding an equation to explain how the intensity of electromagnetic radiation emitted by a black body, i.e. an energy-emitting portion of atomic matter, depends on the frequency of the radiation and the temperature of the body. The term 'black body' refers, essentially, to a black iron stove with a hole drilled in it, such that when the stove is heated, radiation will bounce around inside the cavity of the stove and eventually escape from the hole as black body radiation.[19]

The important point about *black body radiation* is that its properties depend only on its temperature. The curve representing the spectrum of the radiation is shaped like a smooth hill, with a dominate peak at a frequency (color) which depends on its temperature.[20] The hotter the radiation, the higher the frequency at which the peak occurs. When an iron poker is heated in a fire, for example, as the temperature of its body increases, first it glows red (700 nm), then orange (650 nm), then yellow (550 nm), and eventually white hot as the peak of the intensity of the black body radiation it emits shifts across the spectrum. The shape of the black body curve, as shown below, however, had been a mystery, since it could not be explained by the classical physics of Maxwell's field equations:



Black body spectrum

In 1900, however, German physicist Max Planck solved the black body problem by deriving an equation based on the postulate that the total internal energy of the molecular structure of the black body could be divided into discrete energy units. In a paper entitled 'On the Theory of the Energy Distribution in the Normal Spectrum', Planck famously stated that 'if *E* (or U) is considered to be a continuously divisible quantity, this distribution is possible in infinitely many ways. We must consider, however, *E* to be composed of a well-defined number of equal parts and use thereto the constant of nature $h = 6.55 \times 10^{-27}$ erg sec. This constant multiplied by the common frequency ν of the resonators gives us the energy element ε in erg, and dividing *E* by ε we get the number *P* of energy elements which must be divided over *N* resonators.'

Resonators, during these years, were conceptually thought of as vibrating atomic units that emitted energy in the form of radiation. The value *h*, as defined above, is now known as *Planck's constant*. To elaborate further, what Planck essentially did was to apply the first two laws of thermodynamics, namely [3.5] and [4.5], to an energy radiating molecular system, and in doing so postulated that the internal energy *U* of such a system can theoretically be divided into a number of discrete 'energy elements' ε such that each of these energy elements is proportional to the frequency ν with which they each individually radiate energy:[21]

$$\varepsilon = hv \qquad [8.1]$$

To arrive at this relation, Planck reasoned that, according to the first and second laws of thermodynamics, whenever a resonator, with a vibrational energy *U*, temperature *T*, and entropy *S*, radiates a certain quantity of heat *Q*, it will do so in such a manner that the following equation is satisfied absolutely:

$$\frac{dS}{dU} = \frac{1}{T} \qquad [8.2]$$

This expression, which is another variation of the combined law of thermodynamics, is a combination of [3.5] and [4.5] in which the work dW done by the resonator is zero. The entire blackbody problem then, according to Planck, is reduced to determining S as a function of U. Planck subsequently found this relation by reasoning, as Austrian physicist Ludwig Boltzmann had theorized previously, that just as entropy, which is a form of energy, can be partitioned into discrete units, so to can the internal energy of the radiator. This postulate was the start of the quantum revolution.

On a different but related front, in 1904 German chemist Richard Abegg noted that certain elements seemed to have a special stability that depended upon each element's unique valencies, or bonding tendencies. In general, for a given chemical element, such as sulfur, Abegg stated that the sum of the absolute value of its negative valence of maximum absolute value, such as −2 for sulfur in H_2S, and its positive valence of maximum value, such as +6 for sulfur in H_2SO_4, is often equal to eight. This statement, in which the difference between the maximum positive and negative valence of an element is frequently eight, soon came to be known as *Abegg's rule*. It was later used as a basis of argument in American chemist Gilbert Lewis' 1916 ground-breaking article 'The Atom and the Molecule', an article which later inspired American chemical engineer Linus Pauling to write the founding 1938 textbook *The Nature of the Chemical Bond*. Lewis, in particular, used Abegg's rule to develop his cubical atom theory, which later evolved into the 'octet rule'.[22]

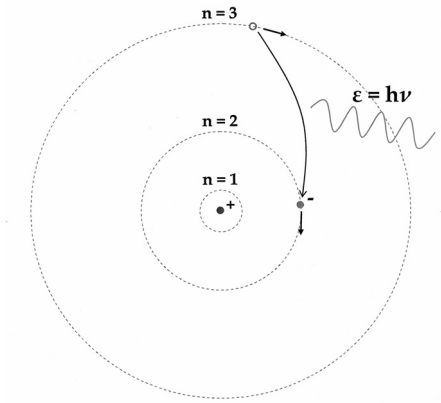
In 1905, in order to explain the *photoelectric effect*, discovered in 1839, i.e. that shining light on certain materials can cause electrons to be ejected from the material, German physicist Albert Einstein used Planck's quantum formula [8.1] as a basis to postulate that visible light, as well as all types of electromagnetic radiation, can be divided into a finite number of 'energy quanta' that are localized points in space. Specifically, from the introduction of his March quantum paper, 'On a heuristic viewpoint concerning the emission and transformation of light', Einstein states:

> "According to the assumption to be contemplated here, when a light ray is spreading from a point, the energy is not distributed continuously over ever-increasing spaces, but consists of a finite number of *energy quanta* that are localized in points in space, move without dividing, and can be absorbed or generated only as a whole."

In short, according to Einstein, not only is the internal energy of a thermodynamic system quantized, but so to is the form of electromagnetic energy, e.g. light, that these systems emit or absorb. This postulate, made by Einstein, was the centerpiece of the quantum revolution.

In 1907, by firing *α-particles*, i.e. bound states of two protons and two neutrons, into thin sheets of gold foil, a former student of Joseph Thomson's named Ernest Rutherford discovered that the positive charges of the atom are centrally confined to a small region of the atom, called the nucleus, rather than spread throughout the body of the atom, as Thomson had originally supposed.[23] Shortly thereafter, it was deduced that the number of electrons in an atom is approximately equal to half its atom weight and that the magnitude of the units of positive charge in the nucleus is approximately equal to the number of electrons in the atom.

In 1913, using Thomson's, Planck's, Rutherford's, and Einstein's models as starting points, to give an updated account of the constitution of atoms and molecules, Danish physicist Niels Bohr showed that normally each electron in an atom is assigned to a particular electron shell or what he called *orbits*, which may be spherical as well as elliptical, but that an electron can move between adjacent orbits only when the atom emits or absorbs a certain quantum amount of radiant energy $h\nu$, as shown below:[24]



Bohr model (1913)

The Bohr atom model depicted here shows a transition between electron orbits three and two, where the energy of the radiation equals $h\nu_{32}$. Electron transitions within the atom, according to Bohr, thus take place between one atomic orbital and another, only accompanied by the emission or absorption of electromagnetic energy, the frequency ν of which is related to the difference between the two orbital energies, E_1 and E_2, by the relation:

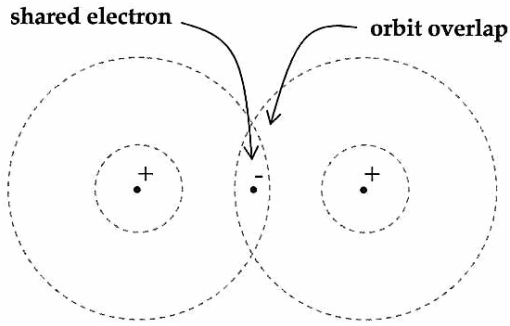
$$E_2 - E_1 = h\nu_{21} \qquad [8.3]$$

Bohr explained that, during each orbit step, as electrons bind tighter to the nucleus, a quantity of energy is *emitted* at a frequency ν, where as, conversely, when electrons debond from the nucleus, i.e. move farther away from the nucleus, during each orbit step, a similar quantity of energy must be *absorbed*. In this manner, Bohr showed, in

a moment of insight, that Planck's energy element is equal to the difference between two energy levels of Thomson's orbits:

$$\varepsilon = E_2 - E_1 \qquad [8.4]$$

Tying this all together, three years later, in 1916 American chemist Gilbert Lewis outlined a number of postulates concerning atomic structure and chemical bonding between atoms. In particular, Lewis stated that each atomic 'shell', which is an older terminology where the structure of the atom was thought to be similar to that of a nut with a central *kernel* (nucleus) and outer *shell* (orbit), tends to hold an even number of electrons, a number which varies during chemical change, between zero and eight, that atomic shells are *mutually interpenetrable*, and that an atomic shell with eight electrons is extremely stable. This latter detail, explained Abegg's rule. Moreover, analogous to Stoney's electron transition theory, Lewis explained that electrons may readily pass between one atomic shell to another and a chemical bond forms when adjacent atoms share electrons in the spatial region of their overlapped shells, as depicted below:



Lewis-type chemical bond (1916)

In his own words:

> "An electron may form a part of the shell of two different atoms and cannot be said to belong to either one exclusively."

Lastly, atomic systems, according to Lewis, tend to rearrange, i.e. bonds tend to form or break, releasing or absorbing energy in the process, until molecular configurations result such that each outer shell holds eight electrons, whether shared or not.[25]

Over the next dozen years, through the works of several others, it was shown that electrons have a wave-like behavior and that when two electrons from separate atoms interact, such that the internal energy of the system is lowered, a Lewis-type chemical bond forms. To cap things off, in 1926 Lewis coined the word *photon* for

Einstein's light quanta. Together, these fundamental theories of orbitals, electrons, bonding, interactions, energy levels, and photon emissions or absorptions constitute the basics of modern molecular structure and chemical bonding. In short, positive nuclei, negative electrons, and electromagnetic photons, which together form the constitution of entities such as human molecules (and thus mediate their behavior), tend to distribute themselves, amongst each other, in space, into a variegated number of geometrical patterns, such that stability results, during each periodic evolution step or chemical reaction in the atomic system.

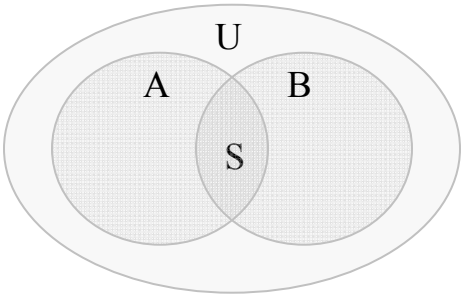
These basic principles, likewise, extrapolate in human chemistry, with specific application to human molecular and interpersonal bonding structure, although in a more advanced and evolved manner. The essential difference is that firstly the electrons found in the outer orbitals of the peripheral atomic structure of the human molecule are called 'sensory electrons'. Second, for these sensory electrons to take part in a chemical bond with another human molecule, they don't technically overlap with the valence orbitals of another person directly, except perhaps during short-term direct body contact, where surface atoms are in contact, but rather they interact by virtue of shared quantum modifications resulting from the sensory exchanges of their mutual surroundings, i.e. interactions with other people and with other objects, which are in each case photon mediated

The single human being, as established, is a single molecule and two humans interactively engaged as a fused couple, united in friendship, or attached as coworkers, etc., are two molecules chemically bonded, to various degrees. Two bonded molecules, from a larger chemical perspective, can thus be defined as one single molecule. As such, the description of the bonds in any molecule is simply the description of the electron distribution in it.[26] Subsequently, the description of the chemical bonds in one human molecular couple, friendship, or association, etc., is thus simply the description of the electron distribution in the relationship, an electron distribution that changes daily due to solar photonic input.

To account for and illustrate this dynamic aspect of human bonding, we will develop the concept of *human orbitals*, which are easily conceptualized as daily human particle movement paths, visualized at an accelerated rate, but described quantum electrodynamically. This theory is modeled on classical molecular orbital theory, as described previously. Human molecular orbital theory states, essentially, that for two human molecules to bond there must first be a certain amount of activity orbital overlap. Two people, for example, who coincidently both go to the same dog-walking park as well as shop at the same health food store, will have a higher propensity or tendency to react and to potentially bond, then as compared to two people who only go to the same store.

Similar to human orbital theory, is the social psychology phenomenon called the *propinquity effect* which states that people, in general, will have a higher tendency to form bonds, associations, friendships, or romantic attachments with those whom they

encounter often.[27] Venn diagrams are typically used to map the propinquity effect, as shown below, where *U* = *universe*, A = *set A*, B = *set B*, and S = *similarity*:



Human activity spheres Venn diagram

The sets, A or B, in Venn diagrams are basically any relevant subject matter about a person, or persons, or non-persons, etc; depending on the context of the use of the word. Propinquity is essentially a physical distance phenomenon. Studies show, for example, that the median distance traveled by an unskilled worker to find his or her spouse is five blocks.[28] Similarly, one study found that over fifty percent of married couples tend to live within one mile of each other at the time of their first date together.[29] In human orbital terms, Venn diagrams translate to the effect that *A* and *B* are each human molecules, moving in their respective daily lives, *S* is their shared life, or orbital overlap, and *U* is the community in which they reside.

Propinquity also relates to spatial arrangement of living facilities. Residents of apartment buildings living near stairs, for instance, tend to have a greater number of friends on other floors than as compared to those not living near stairwells. In a related study, a group of psychologists asked people living in the Dyckman public housing project in northern Manhattan to name their closest friend in the project. The study found that eighty-eight percent of identified 'closest friends' were found to live in the same building and half lived on the same floor.[30] In other words, the confines of one's daily movement orbitals, to a certain extent, predetermines who one will eventually bond with.

Likewise, in a similar study at the University of Utah, students were asked to explain why they were friends with certain others. The typical answer was that their friends shared similar interests to their own. When students were quizzed, however, a different picture emerged: the main factor that explained friendship among students was shared similar activites.[31] Thus, according to this study, a must have for friendship chemical bond formation is a natural or spontaneous inclination towards movements in like *activity circles*. Two people who have a natural tendency or predisposition towards participating in outdoor activities, such as skiing or bungee jumping, for example, will have a higher predisposition towards bond formation.

A related subject is *proxemics*, which is the study, measurement, and analysis of interaction distances between people.[32] The term proxemics, was introduced by American anthropologist Edward Hall in 1966, and is essentially used to describe the subjective circular dimensions that surround individuals and the physical distances one tries to keep from other people, according to subtle cultural rules. The effects of proxemics, according to Hall, can be summarized by the following loose rule:

> Like gravity, the influence of two bodies on each other is inversely proportional not only to the square of their distance but possibly even the cube of the distance between them.

Hall's human distance-spacing theories were largely based on the early animal-spacing studies of German zoologist Heini Hediger, from his 1955 book *Studies of the Psychology and Behavior of Captive Animals in Zoos and Circuses*. Hediger, in animals, had distinguished between *flight distance* (run boundary), *critical distance* (attack boundary), *personal distance* (association distance between close members of the same species, such as between a pair of swans), and *social distance* (intraspecies communication distance, e.g. the distance the sound of a bird call travels).[33]

In animals, according to Hall, we can observe the direction, the rate, and the extent of change in the behavior that follow manipulations in the space available to them. In other words, reproducible scientific studies can show how animals space themselves relative to each other, especially when their spatial living conditions are artificially manipulated. Moreover, animals respond in an amazingly consistent manner so that it is possible to observe repeated and virtual identical performances. Using these principles as a basis, and building on the theory of 'animal territories', a concept introduced in 1920 by English ornithologist Henry Howard, in his book *Territory in Bird Life*, whereby animals associate or attach to particular plots of ground, Hall states that within each territory:

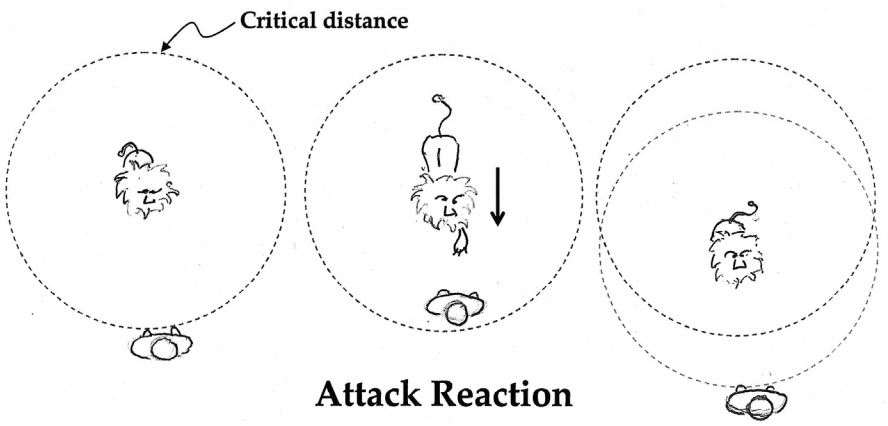
> Each animal is surrounded by a series of *bubbles* or irregularly shaped balloons that serve to maintain proper spacing between the individuals.

In other words, according to Hall, the boundaries of the self extend beyond the body, which serve to regulate intimate, association, or social distances between individuals, in the form of 'reaction bubbles'. These were originally referred to by Hediger as *spheres of action*. Prior to this, similarly, in 1809 French chemist Claude Berthollet positioned the argument that reactions between chemical species occur only within their mutual 'spheres of action' as a result reciprocal affinities (Gibbs free energy interactions) and concurring forces that leads to the exchanges of components.[34]

That same year German polymath Johann Goethe, in his *Elective Affinities*, outlined the revolutionary view that elective affinity reactions between humans, due to chemical forces, occur only within the 'social circles' people move in.

To elaborate on these perspectives, Hall refers to Hediger's conception of flight distance, whereby a wild animal will normally allow a person or other potential enemy to approach only up to a certain distance before it flees. Hediger defines this process as the 'flight reaction'. Similarly, the 'attack reaction' occurs whenever an animal is approached so close that it is forced to attack. The distance at which the *attack reaction* triggers into chemical mechanism is called the critical distance, which according to Hediger can be measured in centimeters.

Using the typical circus-type interaction between a lion and a lion tamer, as an example, Hall depicts the critical distance bubble or attack sphere of the lion, as detailed below, and shows how the lion tamer toys with this known distance, by moving into and out of the lion's critical space, such to trick the lion into moving forward, and then to make the lion pause, at certain points, by moving out of the critical space, thus forcing the lion to climb onto an object, such as a chair, to create a humorous effect:



The critical bubble of the lion, as Hall notes, is modulated by visual feedback alone; whereas, other animals may use, for example, auditory or scent feedback to gauge boundaries.

Next, Hall defines 'personal distance' as that measurement of physical space between social animals of the same species. This distance, according to Hall, acts as 'an invisible bubble that surrounds the organism', where by 'outside the bubble two organisms are not as intimately involved with each other as when bubbles overlap.' Hall also notes that dominate animals tend to have larger personal bubbles than those which occupy lower positions in the social hierarchy. In other words, subordinate animals tend to yield room to dominant ones. In human situations, likewise, it is known that both tall individuals as well as very attractive individuals are given more personal space in crowds.[35]

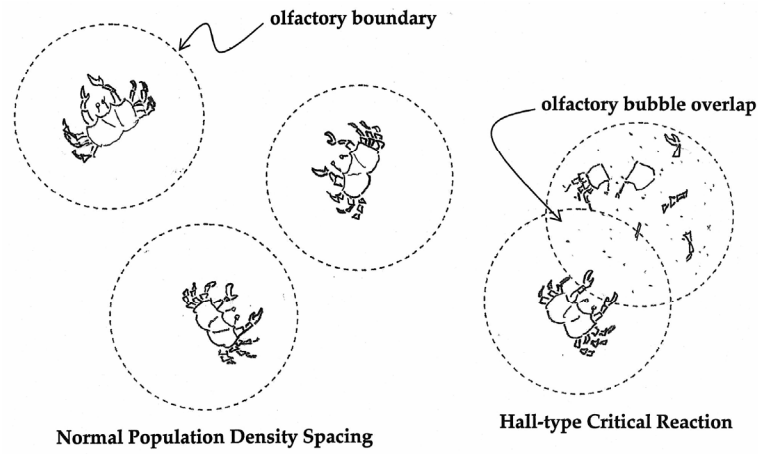
To exemplify what happens when critical bubbles overlap destructively, Hall cites the population density study of the species *Hyas araneus*, also known as the Great spider crab, originally conducted by nature historian Wilhelm Schafer in 1956. The distinguishing feature of this species is that at certain times in their life cycle the crabs shed their hard shell and thus become vulnerable to others of the same species; as a result some are sacrificed to keep the population down. The only way a hard-shelled crab will eat its soft-shelled fellow is if its critical olfactory boundary is crossed, whereby the scent triggers a meal reaction.

Hence, whenever the density of the crab population breaches a certain threshold value, such that the 'critical space' of each crab begins to overlap with that of its neighbor, then a 'critical situation', terms both used by Schafer, develops in which certain individuals are nutritionally removed from the population. With the Great spider crab, this critical reaction, in which one crab attacks and consumes another crab, would technically be a recombination reaction of the form shown below:

$$A + B \rightarrow A—B \rightarrow C + D + E \qquad [8.5]$$

Here, species *A* and *B* are two crabs with no critical scent boundary overlap, before the encounter, *A—B* is the encounter complex, *C* is the nutritionally enhanced crab, after its meal, *D* is the miscellany of waste parts not taken in or incorporated by the structural body of the shelled crab, and *E* is the set of unprocessed excrement released after digestion. In other words, atomic and photonic exchange between species *A* and *B*, in the form of initially scent, resulted in products *C, D*, and *E*.

In critical orbital terms, this molecular bubble reaction process is detailed below, a diagram originally made by Hall:



In chemical terms, the spider crap is approximately a 22-element, water-dwelling, molecule. As such, here we see aberrant reactions triggered into action, ones that normally wouldn't have taken place, but rather do occur due to the effect of having

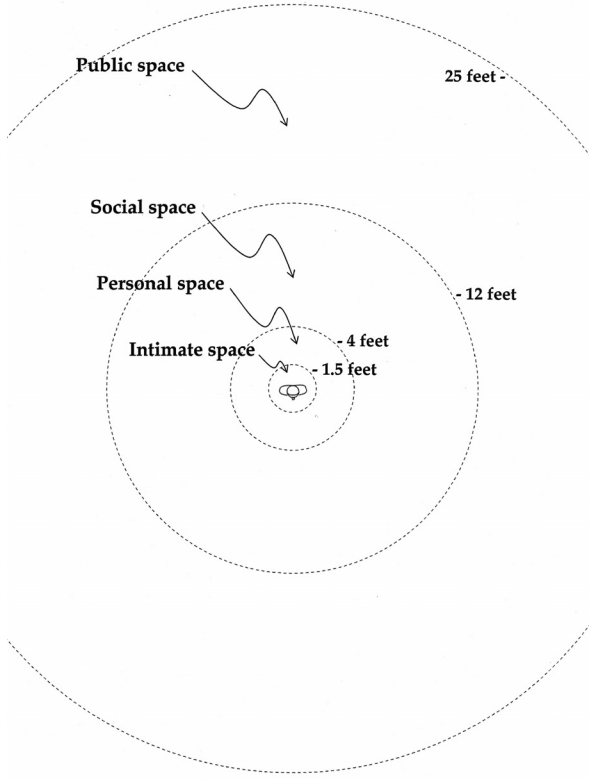
these crustaceous molecules compressed or pressurized into a critical situation. In a similar manner, we might expect that these types of reactions could occur with all molecules. In other words, if we interpret Hall's bubbles as *molecular bubbles*, unique to all molecules, then we might expect to find these types of critical reactions in all molecular systems when put under extreme pressures or densities. Molecules in the gas phase, for example, when compressed or put under extremely high pressures yield many exotic reactions, beyond that of normal pressures. From these examples, we see that 'pressure', which is normally thought of as simply the total kinetic energy of molecules impacting which each other, is actually a more involved process.[36]

In 1950, ethologist and medical pathologist John Christian advanced the thesis that dramatic increases and decreases in mammalian populations are controlled by physiological mechanisms that respond to density. Christian presented evidence showing that as numbers of animals in a given area increase, stress builds up until it triggers an endocrine reaction that acts to collapse the population.[37] An example is the James Island Sika deer population collapse of 1958 and 1959, in which over half of the population died, even though the population had adequate food supply, no predators, and where the bodies were found to be in excellent condition.[38]

In human reaction terms, aside from isolated cases of genocide, wars, and inner-city violence, etc., Hall reasoned that, with very few exceptions, in normal daily life, flight distance and attack distance reactions have been eliminated in the human scenario.[39] Subsequently, to find a more accurate model for determining every-day human reaction or interaction bubbles, Hall interviewed hundreds of people and tallied measurements and criteria for human intimate, personal, social, and public interactions, of all sorts. Inter-personal body spacing, distancing, and posture according to Hall's research findings, are unintentional 'reactions' to sensory fluctuations or shifts, such as subtle changes in the sound and pitch of a person's voice. Social distance spacing between people from around the world, according to Hall, is reliably correlated with physical distance, as are intimate and personal distance, according to the following delineations:[40]

Intimate distance – for embracing, touching or whispering:
Close phase - less than 6 inches
Far phase - 6 to 18 inches
Personal distance – for interactions among good friends:
Close phase - 1.5 to 2.5 feet
Far phase - 2.5 to 4 feet
Social distance – for interactions among acquaintances:
Close phase - 4 to 7 feet
Far phase - 7 to 12 feet
Public distance – used for public speaking:
Close phase - 12 to 25 feet
Far phase - 25 feet of more

People, according to Hall, have a built in reactive tendency to automatically send out repulsive, back-off, signals whenever these boundaries breached, that is, unless they are wanted interactions. Thus, for example, approaching a stranger to within their twelve-foot radius of social interaction comfort may possibly begin to trigger glares of disapproval, questionable comments, or other repulsive types of body movements. These human reaction bubbles are shown below, whereby only select individuals are allowed entry to different energy levels of a person's space:



Edward Hall's 1966 personal space *reaction bubbles*

Again, noting that human molecules, as well as other molecular structures such as lions and crabs, have these *molecular bubbles* (reaction space), which are distinct from that of atomic orbitals, we might reason that all animate molecular structures, from human to hydrogen, have electromagnetic variations of these sensory-type molecular bubbles.

One of the first to speculate in this direction was British mathematician John Rowning who in 1738 suggested that there might be as least three concentric spheres of attraction and repulsion surrounding the particles of bodies. Specifically, 'if this were allowed, and we might go on, and suppose the particles of all bodies to attract and repel each other alternately at different distances, perhaps we might be able to solve a great many phenomena related to small bodies, which are now beyond the

reach of our philosophy. However, upon the supposition of the *three spheres of attraction and repulsion*, just mentioned, nothing is more easy than to see how solids may be converted into fluids, and fluids into solids …'[41]

As such, in modern terms, variations of these molecular bubbles, or personal reaction space, may very well act to facilitate spacing of populations of molecular species, such as molecules in gas phase systems or humans in crowded situations.[36] In short, in regards to that of the spatial distribution or position of different types of molecules in any number of various systems, such as gas phase, liquid phase, surface phase, etc., molecular systems, different human and animal molecules have different sized molecular bubbles. Studies show, for example, that alpha males and alpha females are given more individual or personal space. A supermodel walking alone through a crowd of people will be given more personal space than as compared to a more homely female.[35]

When people are asked to approach a stranger, for example, and stop when they no longer feel comfortable, they will stop about two feet away from a tall person (22.7 inches to be exact) but less than a foot (9.8 inches) from a short person. As height is correlative with physical attractiveness, e.g. shorter than average men and women are less attractive than taller men and women, it is found, according to attractiveness researcher Nancy Etcoff, that:[35]

> "Very attractive people of any size are given bigger personal space and territory; which they carry around with them."

In other words, physically 'hot' molecules trigger volume increase be it a gaseous molecule or a human molecule.

In relation to Planck's quantum hypothesis in connection with Hall's reaction bubble diagram, we can visualize the nature of human quantum interactions. A certain 'quantity' of energy or necessary information, for instance, in the form of conversation, disposition, intelligence level, visual stimulation, social status, character discernment, scent, etc., must be exchanged before two reacting people will let each other enter their personal space, i.e. intimate reaction bubbles (volumes). Subsequently, following quantum approval, within a person's close energetic space further intimate exchanges, e.g. saliva, sperm, vaginal secretion, sweat, etc., may then naturally proceed.

Sexual types of exchange, which occur in the closest reaction bubble, are the most energetic of all quantum exchanges. A potential mate, typically, will have had to have passed all sorts of 'tests' and strict requirements before personal space entry is allowed. Similarly, if money is used as gauge of the quantum in human life, then the world's oldest profession, that of prostitution, where the act of sexual intercourse is exchanged for money, supports the supposition that intimate reaction bubble space

is highly energetic. Said another way, intimate space overlap requires significant quantum exchange prior to future stability. In San Francisco, for example, the cost (exchange) for call-girl services can range from $200 to over $5,000 for more exclusive interactions (intimate space proximity).

In normal relationships, similarly, there is also a 'quantum cost' involved, which usually accrues to the effect associated with the cost involved in raising and developing oneself, prior to meeting a potential mate. As all humans are quantum structures, we should expect that all intimate bubble interactions will be due typically to an inherent energy stabilizing effect related to favored charge distributions resulting during the process of the interaction. Those interactions of charge distributions that are transient in duration, e.g. a blind date that didn't work, would be less stable inherently.

In regards to social space, Hall points out that social animals need to stay in touch with each other and that loss of contact with the group can be fatal for a number of reasons including psychological isolation, environmental exposure, and predator susceptibility. Social distance, according to Hall, is not exclusively the distance the individual can no longer see, hear, or smell the group, but rather it is a psychological distance, one at which the animal apparently begins to feel anxious when the social bubble is exceeded. This meaning that, for instance, when one is out of the social loop, a loss of connectedness results. Hall defines the social attachment bubble as 'a hidden band that connects the group'.

Hall further notes that different cultures maintain different standards of personal space. In Latin cultures, for instance, relative association distances are smaller, and people tend to be more comfortable standing close to each other, whereas in Nordic cultures the opposite is true. We might expect this pattern to be due to average daily temperatures associated with each culture, and with the long-term behavioral trends and the neurochemical tendencies mediated out of this pattern. Heated systems tend to have higher reactions rates, meaning that more product, i.e. offspring, will tend to be produced. Hence, in warmer reactive climates, population densities will be higher and people raised in these environments will naturally be acclimated to being closer; whereas, conversely, those raised in colder climates will be acclimated to being farther apart.

In general, comfortable human molecular reaction bubble distances will depend on the culture, social situation, gender, peer hierarchy, physical attractiveness, neurological attractiveness, and individual preference, among other factors. The essential point to note from these discussions, in regards to favored interpersonal relationships, according to Hall, is that those who naturally have more personal bubble overlap will naturally be more connected. In other words, the greater the amount of bubble or space overlap between two people, the stronger the bond.

These types of studies, theories, and tendencies will be used here as a basis for the development of a human quantum mechanical orbital perspective of life. In

short, Howard's *territories* can be visualized as combinations of Hall's *bubbles* that together combine to form human molecular *orbitals*, which are basically a modified description of Bohr's *quantum* orbital dynamics.[42] Basically, energy in human life, as it is in atomic and molecular life, is quantized. As such, movements, which can be measured energetically, in human life, are a quantum in basis.

The idea that energy is quantized, to note, is far reaching and difficult to grasp and to pin down, let alone to mold into that of an atomic orbital perspective. Nevertheless, as a first approximation, if we model the human molecule as a single particle, then, subsequently, the diurnal movements of the human particle, traced by satellite, or a similar type of tracking, can be easily molded into orbital models. The combined interactions of the responses of the valence shell, i.e. outer atomic orbital, electrons of the peripheral sensory system of the human body to the multitudes of photon exchanges and electron interactions in the environment of each human molecule, as these sensory electrons move and rotate daily in their atomic orbitals and molecular bubbles, from an overarching visual perspective, work to construct human molecular orbitals, as described previously as territories, social spheres, or daily travel paths, etc.

Photons, as discussed, are quantum amounts of light or, in a sense, packets of electromagnetic energy. Technically, a quantum amount of energy is the requisite amount of electromagnetic energy required to change the orbital position of a valance shell electron in an atom. Molecular structural change and movement is what results when valence shell electron positions are changed. If an electron, within an atom of a molecule, absorbs a photon and is thus moved into a less stable position, the molecule itself will be forced to compensate by reconfiguring itself towards a position of stability. Repetitions of these simple molecular quantum mechanical interactions, multiplied many-fold, either increase or decrease the stability of the molecular structure, and together facilitate or function to trigger human particle movement. People, as is the case with all atoms and molecules, tend to strive, in life, speaking loosely, towards configurations of stability.[43]

To review, although a number of scientists contributed to the development of the molecular orbital perspective, the basic turning point in human thought originated from Planck's simple postulate that the internal energy U of an energy radiating atomic system can be divided into a number of discrete energy elements [8.1] and that each unit individually radiates only quantum units of energy, a value proportional to the frequency of the radiation. Planck, as it turns out, derived these viewpoints from his studies in thermodynamics. Specifically, in 1877, while enrolled at the University of Munich, Planck took a year out a year of school to go to Berlin to study with the great physicist Hermann von Helmholtz and while there he undertook a program of self-study of the writings of Rudolf Clausius and soon became fascinated, as we all do, with Clausius' definition of entropy [3.8]. Two years later, he wrote his dissertation on the second law of thermodynamics and later published his famous

1897 *Treatise on Thermodynamics*, one of the first readily available introductory textbooks on thermodynamics, which is still popular to this day.

The central problem in physics, during these years, was to find the solution for the distribution of energy in the normal spectrum of radiating heat. In other words, no one could find an exact formula that would relate the spectral radiance I, or the energy radiated from a black body, per unit time, per unit surface area, per unit solid angle, as a function of the temperature T of the body and the frequency of emitted radiation v.

In 1896, a colleague of Planck's named Wilhelm Wien, who had also worked in the laboratory of Hermann von Helmholtz, derived a partial solution to this problem, that was accurate for low frequencies, but that broke down at high frequencies.[44] To resolve this issue, Planck was driven to find an expression that was accurate at all frequencies. In this direction, Planck reasoned that a radiating body, as is the case with all heat transforming bodies, would be subject to the conditions stipulated by the first and second laws of thermodynamics.[45] The law of energy distribution in the normal spectrum, subsequently, according to Planck's logic, is thus completely determined when one succeeds in calculating the entropy S of an atomic energy resonator as a function of its internal vibrational energy U.

With this in mind, during these years, Planck came across the works of Austrian physicist Ludwig Boltzmann who in 1872, in a paper titled 'Further Studies on the Thermal Equilibrium of Gas Molecules', had formulated an equation to measure entropy from a statistical perspective:

$$S = k \log W \qquad [8.7]$$

Equation [8.7] gives a measure of the entropy of a thermodynamic system in terms of the number of possible microscopic states W an atomic system can possibly occupy, where k is Boltzmann's constant, being equal to the gas constant R divided by Avogadro's number N. Thus, from Planck's view, to measure the entropy of single radiating energy element, which is essentially a vibrating atom, one had to know how to count the number of ways a given amount of total energy can be distributed among a set of radiating units (atoms). Subsequently, it was expression [8.7] that inspired Planck to introduce the idea of the *quanta* or specifically what he called 'energy elements', namely the assumption that the total energy of a radiating body is divided into finite portions of energy, a process known as 'quantization'.[46] This, again, was the start of the quantum revolution.

Later, as mentioned, Einstein showed that if the total internal energy of atomic-molecular structures is indeed quantized then the light energy they emit must also be quantized; and following this, Bohr showed that if both light and matter are quantized then the 'shapes' of atoms and molecules must likewise be quantized. This led to the development of the concept that atoms have electron orbitals and that each

orbital has an associated quantum shape and quantum energy associated with it. On these views, here we will show that human activity orbitals must also have an associated 'quantum' shape and 'quantum' energy associated with them.

To begin with, an *atomic orbital* is defined as the region in which an electron may be found around a single atom.[47] A chemical bond, essentially, is said to form between two atoms whenever inter-atomic orbitals overlap constructively, a state associated with an energy lowering effect in the system and with greater stability. This energy lowering effect associated with the evolution, stability, and bonding of atomic-molecular systems is an observational fact of nature first noted by Bohr in 1913, when he stated that:[24]

> "In any molecular system consisting of positive nuclei and electrons in which the nuclei are at rest relative to each other and the electrons in circular orbits, the angular momentum or every electron round the center of its orbit will be in the permanent state of the system equal to $h / 2\pi$, where h is Planck's constant, and we shall assume that a configuration satisfying this condition is stable if the total energy of the system is less than in any neighboring configuration satisfying the same condition of the angular momentum of the electrons."

This has since been reiterated by others in various forms, as shown below:

Charles Coulson[26] (1952)	Two atoms form a molecule because there is a lowering of the total energy when they come together.
Linus Pauling[48] (1960)	The configuration for the normal state of any molecule is that corresponding to the minimum value of the *energy function*, i.e. the electronic energy of the molecule as a function nuclear configuration, which corresponds to the motion of the electrons in the fields of the atomic nuclei, a minimum which thus gives the molecule a maximum stability.
Britannica[49] (2002)	When atoms approach one another, their nuclei and electrons interact and tend to distribute themselves in space in such a way that the total energy is lower than it would be in any alternative arrangement. If the total energy of a group of atoms is lower than the sum of the energies of the component atoms, then they bond together and the energy lowering is the bonding energy.
Mark Winter[50] (2005)	The geometry that will be adopted by a molecule will be that in which the total energy for all the electrons in that molecule is a minimum.

These statements are the basic rules behind all human behavior. In simple terms, negative electrons moving about a positive nucleus will always tend to distribute

themselves, in different geometric orbital shapes, in such a manner so to lower the energy of the system. To complicate this picture, however, in earth-bound systems, on a diurnal basis, the sun is continuously inputting photons, i.e. quantums of electromagnetic energy, at a rate of about 1,000 billion photons per millimeter per second. This energy input results to naturally punctuate the stability of each atomic-molecular evolution process, i.e. to set the stability of the system out of equilibrium, daily. The system, in turn, must reconfigure each day in the direction of minimum total energy. In human life, this energy principle states that, in any system of reactive human molecules, within each partitioned system's daily evolution, working relationship configurations will result, i.e. bonds will break, form, or transform, such that the total energy of the resultant system is lower than it would be in any alternative arrangement.

To elaborate, when a man sees (photon absorption), for instance, what he conceptualizes as a beautiful woman or when a woman sees what she perceives to be a functionable man in an attractive occupation, the valence electrons of the rhodopsin molecules of that person's retina will configure in such a way so as to generate or trigger an informationally unique nerve impulse, which will resultantly function to compel the molecular structure of that person's body towards the intender, however slightly, and this process, for that instantaneous moment, would result, on average, in the stabilization of the system, which would be attributed to a subtle lowering of the total energy of the interaction. If we were to then add up multitudes of similar micro-movement processes, for all variations of sensory interactions, such as these, we would in effect have a mathematical way to map the tendencies of valence electron interactions with the environment to push or pull the body of the human molecule in various diurnal movement directions such to from quantum movement orbitals.

In short, the mechanism that we are describing is that spontaneous processes are typically associated with stability increases and a total energy lowering effect of the system. This thermodynamic energy lowering principle, as was originally outlined in energy and entropy terms by Willard Gibbs in 1873, is the basis of the modern quantum mechanical tendency, enunciated by Bohr in 1913, that guides the process of molecular evolution.

In quantum chemistry, this dynamic energy lowering concept has evolved into three distinct but related chemical bonding theories. These are *valence bond theory*, in which pairs of electrons are associated with each bond, *molecular orbital theory*, in which electrons are treated as moving in orbits under the influence of the nuclei in the whole molecule, and *density function theory*, in which electron densities are considered rather than the individual electron interactions.[51] Using these quantum theories as base models, we will assemble a rudimentary outline of human chemical orbital bonding.

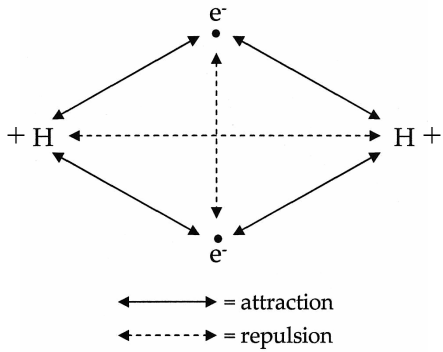
The starting point for any basic theory of human molecular orbital bonding is *Earnshaw's theorem of electrostatics*, which states that no system of point charges, such as positive nuclei and negative electrons, can be in a stable equilibrium while at rest.[52] This theorem, which was proved in 1842 by English mathematician Samuel Earnshaw, means that the stability of an atom, molecule, or molecular system must be a dynamic and not a static one.[26] In other words, a relationship that stagnates will never be a stable one; only dynamic relationships can be stable. Said another way, when someone says 'I don't see our relationship going anywhere', they are referring to Earnshaw's theorem. The human molecule, in particular, is a bound state system of 10^{27} positive and negative point charges. Two or more human molecules interacting are technically defined as a larger system of interactive positive and negative point charges. Human bonding relationships, subsequently, will always be dynamic in character, if they are to be stable. Stagnant relationships, according to Earnshaw's theorem, will always be characterized by instability.

Based on this, the dynamic shape of any molecule is determined by the spatial arrangement of its atomic orbitals, which are themselves spatial approximations of electron dynamics. Said another way, an atomic orbital is the region in which an electron may be found around a single atom.[47] Molecular orbitals are bonded combinations of atomic orbitals. In human chemistry, by extrapolation, these molecular orbital definitions, translate approximately to the correlative, but evolved, visualization of dynamic interpersonal molecular activity orbitals. In other words, over the course of a day, where a person bonds, de-bonds, or interacts with a number of individuals, the question becomes: where on the topographical surface of the earth are the valence electrons of that reactive individual in relation to the people with which that person is thermalizing with in each respective system? As such, the topographical movements of valence shell electrons create human molecular orbitals. Human molecular orbitials, subsequently, are evolved or time-enhanced types of atomic orbitals. Mathematically, each is based on the same basic founding theories.

In the previous chapter, we outlined the idea that stable human bondings hold owing to a balanced ratios of attraction-to-repulsion tendencies, which are dynamic reactions to sensor inputs. To explain this, according to current theories, all molecular structures in the universe, the human molecule included, evolved from interactive systems of hydrogen atoms, a process that began approximately 300,000 years after the Big Bang.[53] The hydrogen atom, itself, is comprised of a positive nuclei and a negative electron. Owing to this unique charge distribution, various hydrogen system attraction and repulsion tendencies result. Human molecules, subsequently, can trace their attraction and repulsion heritage to these beginnings.

In sum, shortly after the early hot universe began to cool, hydrogen atoms formed. Hydrogen atoms then reacted together to form helium atoms. Hydrogen and helium atoms later reacted to form lithium atoms. This early three element system, in certain regions of space, then gravitationally contracted upon itself and reacted to

form stars, inside of which the majority of the remaining elements were formed. The energy released from stars, at an approximation, then fueled the formation of the majority of the remaining molecules in the universe. Thus, all molecular bonding, debonding, and reacting tendencies have their historical origins and mathematical basis in the attraction and repulsion tendencies found in reactive hydrogen atom systems, such as shown below:



The schematic shown above details the attraction and repulsion interactions between the two hydrogen nuclei and the two electrons of the H_2 molecule. In this hydrogen molecule system there are a number of conflicting interactions. Namely, the force between any two point charges varies with the square of the distance between them.[54] As such, the two protons are positively charged and repel each other. Similarly, the two electrons are negatively charged and repel each other. These repulsions, however, are more than offset by the four proton-electron attractions. These six interactions represent the net bonding in the system.[50] Similar to the dihumanide molecular *MxFy* attraction-to-repulsion Gottman stability ratio of 5-to-1, here we see a 4-to-2 stability ratio, where in the dihydrogen H_2 molecular system there are four attractive interactions for every two repulsive interactions. In sum, stability ratios vary per system, yet attraction tends to predominate in stable arrangements.

In order to correctly study the dynamic bonding behaviors in the dihydrogen molecule H_2 system we have to map the movements of the two electrons, in the *x, y, z* plane, about the two nuclei. In this direction, in 1923 French physicist Louis de Broglie showed, from theoretical considerations involving the invariance of certain relativistic formulae, that it was possible to associate waves with a moving particle, such that its wavelength would be inversely proportional to its momentum. De Broglie derived this result by using a simple equation from Einstein's 1905 special theory of relativity. Namely, Einstein showed that the energy E of a photon is equal to the product of its momentum p and the speed of light c:

$$E = pc \qquad [8.8]$$

Thus, knowing that the speed of light is the product of its wavelength λ multiplied by its frequency ν, this can be written as:

$$E = p\lambda v \qquad [8.9]$$

Substitution of [8.1] into this expression, and solving for wavelength, shows that for a moving electron, with a certain momentum, or the particles mass times its velocity, the wavelength of its motion is exactly that which is predicted by what is now called the de Broglie relation:

$$\lambda = \frac{h}{p} \qquad [8.10]$$

where h is Planck's constant. De Broglie also derived this result using certain geometrical arguments and equations from Bohr's atomic theory in which he showed that one electron wave would fit into the first orbit and that two waves would fit into the second orbit.[55]

The next obvious step is that if electrons, themselves, move in the form of waves, there must be what is called a 'wave equation' to describe this movement. This fundamental electron wave equation was formulated by Austrian physicist Erwin Schrödinger, who in 1925 had first heard of de Broglie's ideas on the wave nature of electrons and was so inspired by this that he spend the next year working out a new type of wave mechanics to describe the behavior of an electron in the field the nucleus, starting from simple energy balance equation.[56] He published the results of his findings in a series of six papers in 1926.

Terminologically, any valid solution to the wave equation is called a *wave function* $\psi(x, y, z)$. When the wave equation is solved, there will usually be some regions of space in which ψ (Psi) is positive, and others in which it is negative. Wave functions operate such that the absolute value of the square of the wave function $\psi^2(x, y, z)$, a quantity called the *probability density* ρ, results to give the probability of finding the electron in a certain region of space.

Mathematically, according to the wave equation, a moving particle, e.g. an electron, is represented by a wave function ψ such that $\psi^2 d\tau$ is the probability that it is found in the volume $d\tau$. Moreover, if we assume that the electron is spread out in the form of a cloud, we refer to it as a *charge cloud*, and the density of cloud at any point is proportional to ψ^2. Using the charge-cloud picture we can say that there is a certain contour for each ψ such that 90 percent of the charge or composition of the electron lies within this contour. In this manner the wave function is also called an atomic orbital.

To find the behavior of a certain particle moving under the influence of given forces, according to these definitions, the following procedure is used:[26]

1. Write down the wave equation in a form appropriate to the given conditions.
2. Solve this equation to find a wave function $\psi(x, y, z)$.
3. Determine the probability density by squaring the wave function $\psi^2(x, y, z)$.

In step one, to approximately derive the Schrödinger wave equation, in a roundabout way, we start with the classical law of the conservation of energy:

$$K + U = E \qquad [8.11]$$

Expression [8.11] states that the sum of the kinetic energy K plus potential energy U, for the stationary state of a system, in which the two nuclei are approximated to be unmoving, is equal to its total energy E. For a single particle of mass m moving along the x-axis in a potential field $E_p(x)$, [8.11] becomes:

$$\frac{1}{2}mv_x^{\,2} + U(x) = E \qquad [8.12]$$

Since the momentum of this particle is $p = mv_x$, we can write [8.12] as:

$$\frac{p^2}{2m} + U(x) = E \qquad [8.13]$$

Now, the rule for converting such an equation as [8.13] into a wave equation is to simply replace all occurrences of p by the expression:

$$\frac{h}{2\pi i}\frac{d}{dx} \qquad [8.14]$$

where i equals the square root of minus one. Doing this swap with [8.13] we have:

$$-\frac{h^2}{8\pi^2 m}\frac{d^2}{dx^2} + U(x) = E \qquad [8.15]$$

On the left hand side of [8.15] is what is called a *differential operator*, which tells us to differentiate twice with respect to x. What is missing at this point is the *differential operand*, i.e. that which the operator operates on. This missing piece is the wave function ψ. In this case, ψ is a function of x and by multiplying $\psi(x)$ to each side the wave equation results:

$$\left(-\frac{h^2}{8\pi^2 m}\frac{d^2}{dx^2} + U\right)\psi(x) = E\psi(x) \qquad [8.16]$$

Using the Laplacian operator:

$$\nabla^2 \equiv \frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2} \qquad [8.17]$$

to account for electron movements in three-dimensions, [8.16] is usually written in the more familiar form known as the *time-independent Schrödinger equation* as shown below:

$$\nabla^2\psi + \frac{8\pi^2 m(E-U)\psi}{h^2} = 0 \qquad [8.18]$$

If Planck's 'energy element' theory was the start of the quantum revolution, and if Einstein's 'light quanta' postulate was the center piece of the quantum revolution, then Schrödinger's equation [8.18] was the capstone.

Using Schrödinger's equation, we simply need to find those particular values of energy E for which acceptable wave functions exist. This basically comes down to an iterative method of making intelligent guesses. In general, an acceptable wave function is one which is finite, single-valued, and continuous, and has a gradient that is continuous, and which can be normalized, meaning that the integral of $\psi^2 d\tau$ must be finite.

In 1927, using Bohr's model of the atom, de Broglie's electron wave theory, and Schrödinger's wave equation, Irish physicist Walter Heitler conceptualized the excellent idea that the movements of the electrons, technically called *electron wavefunctions*, which are mathematical expressions involving the coordinates of the electrons in space, can join together mathematically with plus, minus, and exchange terms, to form a Lewis-type covalent bond. The *covalent bond*, prior to this year, was simply defined as a chemical bond characterized by sharing of a certain number of electrons between atoms.[57] Now the basic chemical bond had a quantum description. In this atomic situation, the quantum description for a two electron, two nuclei system is very simple. It is immediately apparent, however, that as the number of atoms in a molecule or molecular system increases and as the number of electrons increases, the situation becomes more complex. The number of interactions that represent the net bonding in any human molecular system is the most complex of systems we have yet to study. Hence, here we will not attempt to derive human molecular orbitals from the Schrödinger equation directly, but will resort to approximations, which will thus serve as a basis for further theoretical development.

The concepts of human molecular orbital models, to note, are in their very initial stages of development and many details remain to be worked out and to be clarified. The quantum chemist will know, obviously and cautiously, that the jump from the hydrogen molecule orbital picture to the human molecule orbital picture is a huge jump, leaving many unknowns left be answered. As such, the models developed here are only meant to be rudimentary starting points. The use of human molecular

orbital models, however, facilitates a visually simple and intuitive perspective of human chemical reaction life. In 'transition states', for instance, when two people collide in time, chemically react together, form, break, and reconfigure interpersonal bonds, fall in love, and transform into a happy married couple, one can show, topographically, what orbitals get reconfigured or dissolved, e.g. when a friendship orbital gets cut off or reduced for the sake of a new marriage bond.

Along these lines, it will be argued herein that successfully bonded couples will tend to have a certain proportion of shared or common activity orbitals, blended together into synergistic, hybridised, or resonating molecular orbitals, more so than non-optimally bonded couples. To give a correlative orbital example, in chemistry the theory of *resonance* is the representation of the structure of a molecule by two or more conventional formulas.[47] Resonance, in general, is a tool used to represent and model certain types of non-classical molecular geometries. Resonance is a key component of valence bond theory and arises when no single conventional model using only even number of electrons shared exclusively by two atoms can actually represent the observed molecule

The concept of 'resonance' was introduced in 1928 by American quantum chemist Linus Pauling after being inspired by the quantum mechanical treatment of the H_2^+ molecule in which a single electron is located between two hydrogen nuclei. The hydrogen ion molecule, according to Pauling, is the 'simplest of all molecules' and the one-electron bond, which involves the sharing of one electron by two atoms, is the 'simplest of all chemical bonds'. The stability of this molecule, which according to quantum mechanic views is associated with favorable inter-nuclei electron distributions, is what accounts for the existence of the chemical bond in this molecule.

In human chemistry, this translates to the effect that chemical bonds in a human molecular structure may at times resonate between two different configurations. A couple, for example, may share, alternate, or resonate with grocery shopping duties and thus fluctuate in that particular activity orbital. The valence electrons of that bi-molecular overlapped orbital system would thus be stabilized, such that this aspect of the inter-nuclei valence electron distributions between the two human molecules is what accounts for the existence of the human chemical bond, in the area of grocery shopping, for this bonded couple. In other words, when two humans bond, instead of sharing one or two electrons directly, as is the case with atoms, the 10^{27} various nuclei that comprise the human molecule share peripheral nervous system valence electron sensory exchanges, in the form of atomic or photonic inputs, with other structures, e.g. a store, and with other human molecules, e.g. a mate. This means that bonds will occur between people when sensory valence electrons, which comprise those affixed human molecules, tend to be found in certain overlapped topographical regions on the earth's surface, according to specific stabilizing probabilities, as based on the laws of quantum electrodynamics.

Stated another way, according to Pauling, a *chemical bond* exists between two atoms or groups of atoms (e.g. two bonded humans) 'when the forces acting between them are such as to lead to the formation of an aggregate with sufficient stability to make it convenient for the chemist to consider it as an independent molecular species'.[48] Thus, when the forces acting between two human molecules, such as for example in an evolving marriage, create sufficient stability to make it convenient for the human chemist to consider the couple an independent molecular species, which is technically called a dihumanide molecule, then we can state that a chemical bond has formed.

This assignment, however, is not exact. There are a great many gradations and variations of the human chemical bond, but for our purposes we can state that a chemical bond between two or more human molecules has formed whenever the sensor valence electrons of associated human molecules tend to be found within the same region of space or common location, on a periodic basis, more than that predicted by random chance. Sensory system valence electrons translate to the equivalent of sensory system orbitials. Similarly, in chemistry it is known that species will bond if their orbitals become lower in energy when they interact with each other.[58] Thus, two people, with activity orbital overlap, who begin to interact, will bond if and only if their orbitals become lower in energy as a result of the interaction.

To elaborate further on the concept of human molecular resonance, such as when the activity orbitals of two bonded people resonate, the methane molecule will be used as an example. The formula of methane can be represented by the covalent structure $CH_3{=}O$, in which there is a double bond in the carbonyl group $C{=}O$. It is known, however, that in such compounds the oxygen has some negative charge and the carbon atom some positive charge. Subsequently, the true bonding in the molecule is somewhere between $H_2C{=}O$ and the ionic compound $H_2C^+O^-$ in which case the morphed bonded structure between the two molecules, called a *resonance hybrid*, is indicated by:

$$H_2C{=}O \leftrightarrow H_2C^+O^- \qquad [8.19]$$

In other words, the inter-atomic bonds are a fluctuated blend of both structures, to a certain extent, between the correlative attached units in the bonded molecular structure. Resonance hybrids are generally more stable than any of the separate structures they represent. The delocalization of the electrons over the entire bonded structure of the molecule lowers the orbital energy, imparting stability, which correlates with strong bonding. The gain in stability of the resonance hybrid over the most stable of the canonical structures is called *resonance energy*.[59]

The concept of resonance energy likewise applies in human molecular life. When two people share bank accounts, living expenses, or utilities, for example, a

certain amount of expense resonance energy is freed up due to the pairing efforts of the union. Each person will have to work less to afford the same or greater lifestyle. Similarly, one person P_1 may resonate in their bonding energy between their two friends P_2 and P_3, bonding tighter to one person at times and tighter to second friend at other times:

$$P_2P_1=P_3 \leftrightarrow P_2=P_1P_3 \qquad [8.20]$$

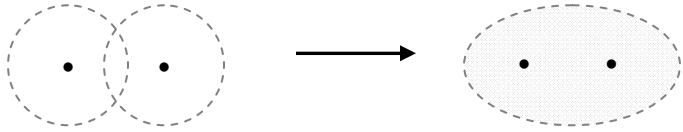
To apply these types of human resonance theories to more advanced variations of relationship scenarios, we must first develop the concept of human molecular 'hybrid orbitals', which is the concept of mixing atomic or molecular orbitals to form new *hybrid orbitals* suitable for the qualitative description of atomic bonding properties.[60]

In the chapter to follow we will specifically draw out orbitals to elaborate on this, but a simple human orbital hybridization example would when two bonding people share or alternate cleaning duties or child care responsibilities. Sharing duties, such as alternating dry cleaning pickups, is akin to sharing activity orbitals. Successful human molecular resonance hybridization between couples, subsequently, should theoretically correlate with a gain in relationship stability, a resultant effect that can be measured in terms of a couple 'resonance energy'.

Research shows, for instance, that in comparing couples who remained together for more than five years with couples who split up, that couples who stayed together were sixty-four percent more likely to be able to identify shared interests.[61] Shared interests, quantum mechanically, translates to shared orbitals. Moreover, according to relationship researcher David Niven, from his exceptional book *The 100 Simple Secrets of Great Relationships – What Scientist have Learned and How You Can Use it*, shared interests, between bonded pairs, is one of the top twenty successfully simple secrets of great relationships.[62] Without shared interests, such as having an interest in common friends, common pastimes, e.g. camping, partying, going to the theater, exercising, favorite restaurants, etc., couples may end up living parallel lives under a single roof as cohabitating strangers, with little bonding glue between them. Common interests, according to Niven, 'encourage positive communication, fun, and strengthen the sense of connection between partners.'

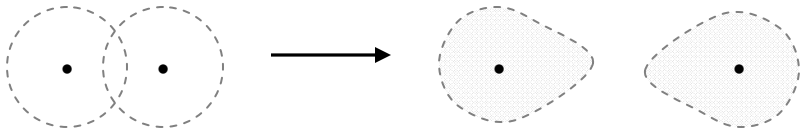
Shared interests, can be visualized in terms of shared human activity orbitals, e.g. two people who attend the same educational facility, go to similar social events, hangout at the same places, etc. To elaborate on this, in chemistry, for each atomic orbital overlap there is a correlative and measurable 'interaction energy' that is associated and controlled by the extent of the spatial overlap of the intertwined orbitals. Molecular orbitals, to clarify, are generally divided into three types:[63]

Bonding orbitals – those atomic orbitals in which the valence electrons of the associative atoms have a higher probability of being between adjacent nuclei and as such hold the nuclei together due to electron-nuclei potential energy lowering effects.



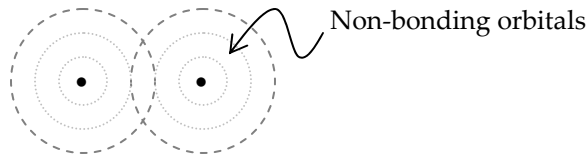
Constructive interaction Bonding orbital

Antibonding orbitals – those atomic orbitals in which valence electrons of the associative atoms tend to be present in a molecular orbital in which they spend more time elsewhere than between the nuclei and as such tend to weaken the bond due increases in the potential and kinetic energies of the electrons.



Destructive interaction Antibonding orbital

Nonbonding orbitals – those in which the electrons are in deep orbitals, i.e. those closely attached to the atomic center, and associated almost entirely with one nucleus or the other and as such spend equal time between each nuclei or not and neither contribute nor detract from the bond strength.



Orbital overlap

Bonding orbitals result to attract the constituent orbital particles, e.g. the associated nuclei or individual human molecules, and antibonding orbitals function to repel. In an opposite sense, a*ntibonding orbitals* repel the constituent orbital particles apart from each other due to electromagnetic debonding effects. *Nonbonding orbitals* are those electrons so close to the nucleus that they essentially have no chemical function and are dormant.

In human terms, for instance, two people who both like going to baseball games, will have a stadium bonding orbital in common. Similarly, two high school friends who coincidently both go to the same gym and later end up going to the same college and getting the same degrees will have bonding orbitals at each of those locations and as a result will tend to be tighter in friendship because of this.

In the opposite sense, a newly dating couple who have friendships in dissimilar locations (or in some cases, dissimilar social spheres), at direct opposite ends of the town, will be antibonding in that sense, as it is energy absorbing to simultaneously visit disparate locations. A person's home can also turn into an antibonding orbital. A person may sometimes get to the point that he or she spends so little time at home, for whatever reasons, that essentially one small perturbation could potentially detach them forever from that orbital. A married couple in a rocky marriage may be antibonding at their home and spend little time there. Antibonding orbitals between two human molecules can also be attachment sites containing or made up of fundamentally different or incongruous elements, i.e. those markedly distinct in quality or character. Two people from different walks of life or social classes who attempt to bond may for example be anti-bonding, from one person's perspective, e.g. the local rodeo may be attractive to one but repulsive to another.

Nonbonding orbitals in human terms are difficult to assign. Technically, they are electrons in atomic orbitals close to the nucleus and as such they do not take part in bonding dynamics, i.e. they are non-reactive orbitals. In short, they are electrons bound tightly to the nucleus. Nevertheless, if we assign the home to be the nucleus, in human molecular terms, then we might reasonably use the non-bonding model to define human molecular non-bonding orbitals to be those involved with the essential or basic needs of living, e.g. sleeping, taking a shower, eating breakfast, etc., i.e. solo activities.

In sum, the electrons involved in bonding between humans are, as mentioned, still valence electrons, i.e. peripheral nervous system valence electrons, only the situation is more intricate due to the time-averaged effects of daily human movements. To effectively study dynamic bonding between humans, one must track bonding interactions over time periods of weeks, months, and years. What is essential to track is the location over the surface of the earth of the sensor system valence electrons of reaction pairs over extended time frames and reaction windows. Tracking these valence electrons leads to the visual conception of daily, weekly, and monthly human molecular movement orbitals.

In this manner, the process of interpersonal bonding can be categorized by postulating the existence of bonding and antibonding interpersonal human molecular orbitals. Two people, for instance, will tend to adhere better when there are fewer antibonding orbitals between them. Moreover, the construct of human molecular movement orbitals facilitates the 'mechanistic visualization', i.e. a step-by-step chemical reaction mechanism view, of the bonding reconfigurations that occur during and throughout, for example, the transition state process in which an unattached pair becomes a married-pair, over the course of several years.[64] This conception, leads to a theory of human molecular orbitals, as will be detailed in the next chapter.

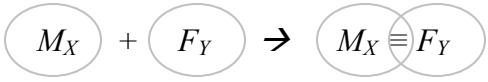
9 – Human Molecular Orbitals:

"As more and more is learned about both men and animals, it becomes clear that the skin itself is a very unsatisfactory boundary or measuring point for crowding … like molecules that make up all matter, living things move and therefore require more or less fixed amounts of space."

Edward Hall, *The Hidden dimension* - 1966

Through the decisive works of Clausius (1857), Maxwell (1859), Boltzmann (1872), Planck (1900), Bohr (1913), Lewis (1916), Schrödinger (1925), Heitler (1927), and numerous others, nature has shown to us that not only is all of matter, in the form of atoms and molecules, or quarks and leptons, and energy, in the form of force exchange particles, quantized, but that the shapes of these multifarious interactions unite in the form of quantized probability orbitals. In chemistry, this quantum principle actuates to the effect that atomic orbitals overlap to form bonded combinations of molecular orbitals. In human chemistry, this quantum principle actuates to the effect that human activity orbitals are quantized and more importantly that the overlap of orbitals between reactive human molecules functions to instill a bonding phenomenon, due to energy lowering effects.

In short, when two human molecules, M_x and F_Y, collide, meet, interact, and begin to exchange visual signals, conversation, emotion, information, etc., in a favorable reoccurring sequence, in a specific spatial location, it can be shown that the activity 'orbits' of the two human molecules, in most cases, have added together mathematically to satisfy the energetics of what is called a *wave equation*. This chemical reaction is shown below using the conception of Hall's reaction bubbles:



[9.1]

Hall's bubbles, as shown here, can be thought of as model human *reaction activity orbitals*, which comprise the quantum sensory interactions about each molecule. Historically, many people contributed to the basics of the molecular orbital theory. To elaborate, the following terse timeline shows the key steps and people involved in the early development of molecular orbital theory, where chemical bonds form owing to the energy lowering effects of inter-atomic favored (stabilizing) dynamic overlap of quantum mechanical electron orbitals:

Molecular Orbital Theory Timeline

Luigi Galvani (1771)	Noted that the muscles of dead frogs twitched when struck by a spark, to which he referred to as “animal electricity”.
Alessandro Volta (1800)	Invented the “voltaic pile”, or battery, specifically to disprove Galvani's animal electricity theory (1771).
Jöns Berzelius (1831)	Based on his chemical experiments with Volta's battery (1800), he outlined an “electrochemical theory” in which a salt has an atomic structure composed of an acid, with a negative charge, and a base, with a positive charge.
Michael Faraday (1838)	Using Volta's battery (1800), he discovered “cathode rays” when, during an experiment, he passed current through a rarefied air filled glass tube and noticed a strange light arc starting at the anode (positive electrode) and ending at the cathode (negative electrode); rays which later led to the discovery of electrons.
Edward Franklin (1852)	Initiated the theory of valency by proposing that each element has a specific “combining power”, e.g. some elements such as nitrogen tend to combine with three other elements (e.g. NO_3) while others may tend to combine with five (e.g. PO_5), and that each element strives to fulfill it’s combining power (valency) quota so as to satisfy their bonding affinities.
Gustav Kirchhoff (1859)	Stated the "black body problem", i.e. how does the intensity of the electromagnetic radiation emitted by a black body depend on the frequency of the radiation and the temperature of the body? This problem led to the development of the theory of the “quantum”.
Ludwig Boltzmann (1877)	Suggested the possibility that the energy states of a physical system could be discrete. This led to development of the “energy element”.
Alfred Mayer (1878)	Performed the “floating magnets experiment” which showed that when negative point charges are in the vicinity of one large positive charge, they will arrange into concentric rings of stability.
William Crookes (1879)	Showed that cathode rays (1838), unlike light rays, can be bent in a magnetic field, which was a clue to the conception of the “electron”.
Alfred Werner (1891)	Proposed a theory of affinity and valence in which affinity is an attractive force issuing from the center of the atom which it acts uniformly from towards all parts of the spherical surface of the central atom; and in 1893 showed that the number of atoms or groups associated with a central atom (the “co-ordination number”) is often 4 or 6; up to a maximum of 8 (a precursor to the octet rule).
Heinrich Hertz (1892)	Showed that cathode rays (1838) could pass through thin sheets of gold foil and produce appreciable luminosity on glass behind them; thus proving that the rays could not be comprised of atoms.
Henri Becquerel (1896)	Discovered “radioactivity” a process in which, due to nuclear disintegration, certain elements or isotopes spontaneously emit one of three types of energetic particles: alpha particles (positive charge), beta particles (negative charge), and gamma particles (neutral charge).

Joseph Thomson (1897)	Showed that cathode rays (1838) bend under the influence of both an electric field and a magnetic field and to explain this he suggested that cathode rays are negatively charged subatomic electrical particles or “corpuscles” (electrons), stripped from the atom; and in 1904 proposed the “plum pudding” model in which atoms have a positively charged amorphous mass (pudding) as a body embedded with negatively charged electrons (raisins) scattered throughout in the form of non-random rotating rings.
Max Planck (1900)	To explain black body radiation (1859), he suggested that a “working body” could be divided into discrete “energy elements” and that electromagnetic energy could only be emitted in quantized form, i.e. the energy could only be a multiple of an elementary unit $E = hv$, where h is Planck's constant and v is the frequency of the radiation.
Gilbert Lewis (1902)	To explain the Werner’s valence-affinity model (1893), he developed the “cubical atom” theory in which electrons in the form of dots were positioned at the corner of a cube and suggested that single, double, or triple bonds result when atoms are held together by pairs of electrons located between the atoms (1916).
Richard Abegg (1904)	Noted the pattern that the numerical difference between the maximum positive valence, such as +6 for H_2SO_4, and the maximum negative valence, such as -2 for H_2S, of an element tends to be eight “Abegg’s rule”; this led to the development of the “octet rule” (1916).
Albert Einstein (1905)	To explain the photoelectric effect (1839), i.e. that shining light on certain materials can function to eject electrons from the material, he postulated, as based on Planck’s quantum hypothesis (1900), that light itself consists of individual quantum particles (photons).
Ernest Rutherford (1907)	To test the plum pudding model (1904), he fired, positively-charged, alpha particles (1896) at gold foil and noticed that some bounced back thus showing that atoms have a small-sized positively charged atomic nucleus at its center.
Niels Bohr (1913)	To elaborate on Thomson’s plum pudding model (1904) in terms Einstein’s light quanta hypothesis (1905) in conjunction with Rutherford’s findings (1907), Bohr hypothesized that negatively charged electrons revolve around a positively charged nucleus at certain fixed “quantum” distances and that each of these “spherical orbits” has a specific energy associated with it such that electron movements between orbits require “quantum” emissions or absorptions of energy.
Arnold Sommerfeld (1916)	To account for the Zeeman effect (1896), i.e. that atomic absorption or emission spectral lines change when the light is first shinned through a magnetic field, he suggesting that there might be “elliptical orbits” in atoms in addition to spherical orbits.
Irving Langmuir (1919)	Building on the work of Lewis (1916), he coined the term "covalence", meaning that atoms can share valence or share two electrons, and postulated that coordinate covalent bonds occur when the electrons of a pair come from the same atom.
Louis de Broglie	Postulated that electrons in motion are associated with waves the

(1923)	lengths of which are given by Planck's constant *h* divided by the momentum of the *mv* = *p* of the electron: *λ* = *h* / *mv* = *h* / *p.*
Friedrich Hund (1925)	Outlined the "rule of maximum multiplicity" which states that when electrons are added successively to an atom as many levels or orbits are singly occupied as possible before any pairing of electrons with opposite spin occurs and, building on Lewis' 1916 paper, made the distinction that the inner electrons in molecules remained in atomic orbitals and only the valence electrons needed to be in molecular orbitals involving both nuclei.
Wolfgang Pauli (1925)	Outlined the "exclusion principle" which states that no two identical fermions, i.e. particles such as electrons, neutrons, or protons, whose spin quantum number is an odd multiple of ½, may occupy the same quantum state simultaneously.
Erwin Schrödinger (1926)	Used De Broglie's electron wave postulate (1924) to develop a "wave equation" that represented mathematically the distribution of a charge of an electron distributed through space, being spherically symmetric or prominent in certain directions, i.e. directed valence bonds, which gave the correct values for spectral lines of the hydrogen atom.
Werner Heisenberg (1926)	Developed the theory of "exchange forces" by which a bond requires that the wave function for two or more identical particles exchanged must have definite symmetry properties, i.e. it must have plus or minus the same value, with respect to the coordinates of those particles and in 1932 applied perturbation theory to the two-electron problem and showed how resonance arising from electron exchange could explain exchange forces.
Walter Heitler (1927)	Used Schrödinger's wave equation (1926) to show how two hydrogen atom wavefunctions join together, with plus, minus, and exchange terms, to form a covalent bond (1919).
Robert Mulliken (1927)	Working in coordination with Hund, he developed a molecular orbital theory where electrons are assigned to states that extend over an entire molecule and in 1932 coined the word "orbital" and introduced many new molecular orbital terminologies, such as "σ bond", "π bond", and "δ bond".
Linus Pauling (1928)	In an article entitled "On the Nature of the Chemical Bond", he used Heitler's quantum mechanical covalent bond model (1927) to outline the quantum mechanical basis for all types of molecular structure and bonding and suggested that different types of bonds in molecules can become equalized by rapid shifting of electrons, a process called "resonance" (1931), such that resonance hybrid orbitals contain contributions from the different possible electronic configurations.
John Lennard-Jones (1929)	Introduced the linear combination of atomic orbitals (LCAO) approximation for the calculation of molecular orbitals.
Charles Coulson (1938)	Made the first accurate calculation of a molecular orbital wavefunction with the hydrogen molecule and in 1952 published an influential basic quantum molecular orbital textbook called *Valence*.

In 1938, Pauling tied all of this together when he published his famous textbook *The Nature of the Chemical Bond*, where, for the next several decades, this became the foundation book in modern chemistry. Other influential publications include Heitler's 1945 *Elementary Wave Mechanics*, and Coulson's 1952 *Valence*. These early textbooks, among others, served as primary references for chemists in the 20th century. With the development of efficient computer technology in the 1940s, the solutions of elaborate wave equations for complex atomic systems began to be a realizable objective. In the early 1950s, the first semi-empirical atomic orbital calculations were carried out. The first *ab initio* calculations on diatomic molecules were carried out in 1956 at MIT. The first polyatomic calculations using Gaussian orbitals were carried out in the late 1950s.

In 1964, Hückel method calculations, which are a simple LCAO method for the determination of electron energies of molecular orbitals of π electrons in conjugated hydrocarbon systems, such as ethene, benzene and butadiene, were generated on computers at Berkeley and Oxford. In the early 1970s, efficient computer programs such as ATMOL, IBMOL, and GAUSSIAN, etc., began to be used to speed up the calculations of molecular orbitals. During 1980s, the basic science of *computational chemistry*, i.e. the branch of chemistry that uses results in theoretical chemistry, incorporated into efficient computer programs, to calculate the structures and properties of liquids, solids, and molecules, began to assemble. The *Journal of Computational Chemistry* was first published in 1980.

Presently, computational chemists can routinely and very accurately calculate the properties of molecules that contain up to 40 electrons.[1] Human molecules, by comparison, contain over 10^{27} electrons, thus making the field of 'computational human chemistry', a future endeavor.

The most important points to note from this historical overview are that firstly in 1913 Bohr postulated that electrons are found in quantum 'orbits' about the nucleus. Following this, in 1923, de Broglie reasoned that each electron has a wave-like movement. Two years later, in 1925, Schrödinger put these ideas together into the form of a basic wave equation. On the heels of Schrödinger, in 1926, Heisenberg developed the theory of exchange forces. Lastly, in 1927 Walter Heitler showed how wave equations could add together mathematically to create chemical bonds. This latter step took into account the energetic nature of the electron, in the field of the nucleus, and its wave-like nature. By 1950, molecular orbitals were completely defined as eigenfunctions (wave functions) of the self-consistent field Hamiltonian (three-dimensional energy function) and it was at this point that molecular orbital theory became fully rigorous and consistent. These key developments summarize the modern-day view that electrons in atoms and molecules move in quantum mechanical orbitals and that the stabilizing interaction or overlap of orbitals is what accounts for chemical bonding.

Molecular orbital theory, thus, is a quantum-mechanical model concerned with the description of the discrete energy levels associated with electrons in molecules. Moreover, the probability of finding an electron in a given region can be obtained by solving the Schrödinger wave equation. In quantum mechanics, the Schrödinger wave equation is an expression used to determine the wave function of a particle.[2] A wave function, as defined, is a mathematical expression involving the coordinates of an electron in space.

Starting with the Schrödinger wave equation and attempting to derive human molecular orbitals is called a *bottom-up approach*. A second method is called a *top-down approach*. This involves the use of more indirect methods to construct human molecular orbitals, those such as topographical thermodynamic free energy maps, Feynman diagrams, satellite tracking, video recordings, average daily time usages data sets, in-person interviews, etc. The long-term goal of human molecular orbital theory is to unify these two approaches.

With this in mind, the essential focus here will be to show that human bonding orbitals reconfigure to a significant effect during transition states. In other words, people obviously like forming bonds and, in other situations, also naturally like breaking bonds. Historically, many preliminary bonding or orbital-type theories led the development modern-day molecular orbital theory. Along these lines, the following section will expand a bit on the previous timeline.

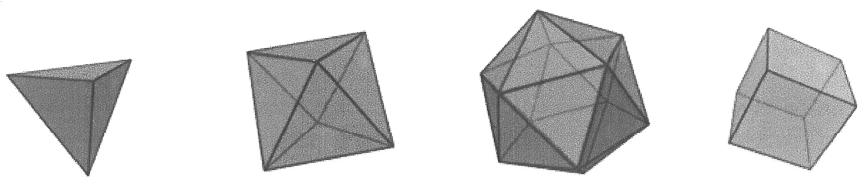
Molecular orbital bonding precursors

In the history of chemistry, the concept of atomic or molecular orbitals followed the gradual development of the various theories of atoms. In about 485 BC, the Greek philosopher Parmenides famously stated the ontological argument against nothingness, essentially 'denying the possible existence of a void'. In 460 BC, Greek philosopher Leucippus, in opposition to Parmenides' denial of the void, proposed the *atomic theory*, which reasoned that everything in the universe is either atoms or voids; a theory which, according to Aristotle, was stimulated into conception so to purposely contradict Parmenides' argument. In the years to follow, specifically in about 450 BC, Leucippus' pupil Democritus went on to further develop the atomic hypothesis using the term 'atomos', which means uncuttable.

The earliest views on the shapes and connectivity of atoms was that proposed by Leucippus, Democritus, and later the Greek philosopher Epicurus, in 300 BC, who reasoned that the solidness or properties of the material corresponded to the shape of their constituent atoms. Thus, iron atoms are solid and strong with hooks that lock them into a solid; water atoms are smooth and slippery; salt atoms, because of their taste, are sharp and pointed; and air atoms are light and whirling, pervading all other materials.[3] It was Democritus, however, that was the main proponent of this view. Using analogies from our sense experiences, he gave a picture or an image of an

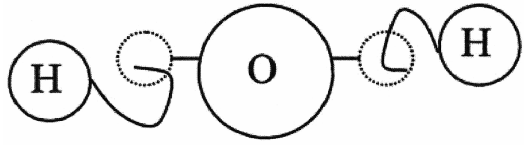
atom in which atoms were distinguished from each other by their shape, their size, and the arrangement of their parts. Moreover, connections were explained by material links in which single atoms were supplied with attachments: some with hooks and eyes others with balls and sockets.[4]

Similarly, the term 'elements' (*stoicheia*) was first used by the Greek philosopher Plato in about 360 BC, in his dialogue *Timaeus*, which includes a discussion of the composition of inorganic and organic bodies and is a rudimentary treatise on chemistry. Plato assumed that the minute particle of each element had a special geometric shape: tetrahedron (fire), octahedron (air), icosahedron (water), and cube (earth):



Tetrahedron (fire) Octahedron (air) Icosahedron (water) Cube (earth)

The atomic theory, curiously, was abandoned for nearly two millennia in favor of the various four element theories, such as Plato's *elemental theory*, and later alchemical theories, such as the 13th century Arabic theory of *three principles*, in which all forms of matter had ratios of sulphur, mercury, and salt in them. The 17th century, however, saw resurgence in the atomic theory primarily through the works of the French philosophers René Descartes and Pierre Gassendi as well as most notably by English physicist Isaac Newton. Using earlier Greek atomic theories to explain how the tiniest particles of matter bonded together, Descartes visualized that atoms were held together by microscopic hooks and barbs.[5] Subsequently, the molecular theory put forward by Descartes was that some atoms were furnished with hook-like projections, and others, with eye-like ones. He held that two atoms combined when the hook of one got caught in the eye of the other, such as shown below:



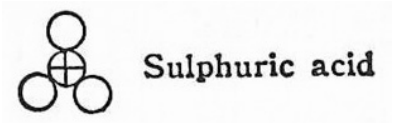
Descartes' 1625 hook-and-eye molecule bonding model

Similarly, Gassendi, who had recently written book on the life of Epicurus, reasoned that by accounting for the sizes and shapes of atoms moving in a void, one could then account for the properties of all matter. Heat was due to small, round atoms; cold, to pyramidal atoms with sharp points, which accounted for the pricking sensation of severe cold; and solids were held together by interlacing hooks.[6]

Newton, though he acknowledged the various atom attachment theories in vogue at the time, i.e. 'hooked atoms', 'glued atoms' (bodies at rest), and the 'stick together by conspiring motions' theory, rather believed that particles attract one another by some force, which 'in immediate contact is extremely strong, at small distances performs the chemical operations, and reaches not far from particles with any sensible effect.'[7]

In a more concrete manner, however, the concept of aggregates of bonded atoms, i.e. 'molecules', can be directly traced to Robert Boyle's 1661 hypothesis that matter is composed of 'clusters of particles' and that chemical change results from the rearrangement of the clusters.[8] Boyle argued that matter's basic elements consisted of various sorts and sizes of particles, called 'corpuscles', which were capable of arranging themselves into groups.

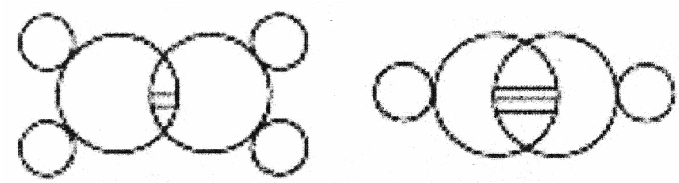
In 1803, English chemist John Dalton assigned the atomic weight of hydrogen, the lightest element, as unity, and determined, for example, that the ratio for nitrous anhydride was 2 to 3 which gives the formula N_2O_3. Interestingly, being influenced by Descartes, Dalton incorrectly imagined that atoms 'hooked' together to form molecules. In any event, in 1808 Dalton published his famous diagrams of combined atoms in which each atom had a circular symbol. Below, for example, is his diagram for one molecule of sulfuric acid H_2SO_4:



Dalton's 1808 sulfuric acid molecule

The center cross-circle is Dalton's symbol for the sulfur atom and the open-circles represent the oxygen atom. We now know, of course, that the central sulfur atom, in sulfuric acid, is bonded to four oxygen atoms in a tetrahedral arraignment; nevertheless, Dalton's model is an excellent first approximation. Other atoms, drawn by Dalton, included a hydrogen atom (circle with a dot), nitrogen atom (circle with a line), carbon atom (black circle), oxygen atom (open circle), and other variations, etc., whereby each distinct molecule was an attachment of atomic circles. Dalton, however, showed no overlap of atomic circles.

In 1863, an unknown Vienna high-school teacher named Joseph Loschmidt published, at his own expense, a booklet entitled *Chemische Studine I*, containing pioneering molecular images showing ringed structures with double and triple bonds as well as orbital overlap:[9]



Loschmidt's 1861 molecule drawings of ethylene $H_2C{=}CH_2$ and acetylene $HC{\equiv}CH$

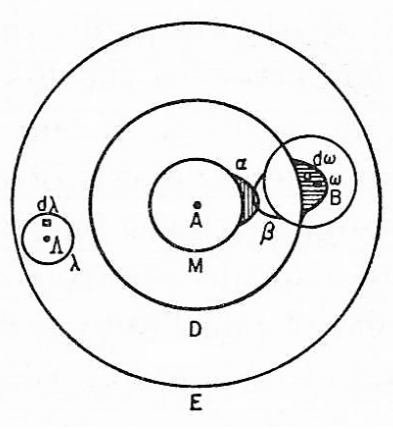
With great foresight, we see that Loschmidt uses a greater amount of molecule or orbital overlap to signify a greater or stronger bonding effect as the bond order increases, i.e. triple bonds have more orbital overlap than double bonds.

In 1898, Ludwig Boltzmann, in his *Lectures on Gas Theory*, used the theory of valence to explain the phenomenon of gas phase molecular dissociation and in doing so diagrammed one of the first-ever rudimentary yet detailed atomic orbital overlap drawings. Noting first the known fact that molecular iodine vapor I_2 dissociates into atoms at higher temperatures:

$$I_2 \rightarrow I + I \qquad [9.2]$$

Boltzmann states that we must explain the existence of molecules composed of two atoms, the 'double atom' as Boltzmann calls it, by an attractive force acting between the two atoms. Boltzmann reasons that this chemical attraction, owing to certain facts of chemical valence, must be associated with a relatively small region on the surface of the atom called the 'sensitive region'.[10]

Boltzmann states that this sensitive region will lie on the surface of the atom, *or may partially lie inside the atom*, and will firmly be connected to it. Specifically, he states 'only when two atoms are situated so that their sensitive regions are in contact, or partly overlap, will there be a chemical attraction between them. We then say that they are chemically bound to each other.' This picture is detailed below, showing the *α-sensitive region* of atom-A overlapping with the *β-sensitive region* of atom-B:

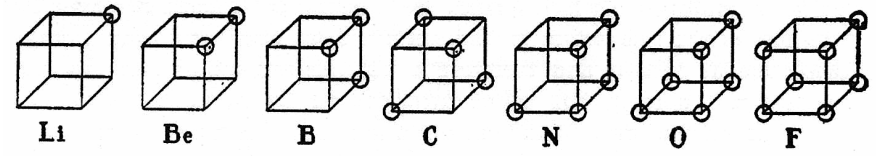


Boltzmann's 1898 I_2 molecule diagram showing atomic 'sensitive region' (α, β) overlap.

Curiously, in spite of the existence of these types of orbital molecular drawings, in the early part of the 20th century, Descartes' hook-and-eye bonding method was still being taught in college. In 1901, however, while teaching undergraduate chemistry students at Harvard, Gilbert Lewis began to use dots in lecture to represent the

electrons around atoms. His students favored these drawings, which stimulated him in this direction. From these lectures, Lewis noted that elements with a certain number of electrons seemed to have a special stability. To Lewis it appeared that once a core of eight electrons had formed around a nucleus, the layer is filled, and a new layer is started. Lewis also noted that various ions with eight electrons also seemed to possess an extra amount of stability. On these views, he proposed the rule of eight or the *octet rule*: 'ions or atoms with a filled layer of eight electrons have a special stability'.[11]

Moreover, noting that a cube has eight corners Lewis envisioned an atom, similar to Plato's earth element, as having eight sides available for electrons, like the corner of a cube:



Lewis' 1916 cubical atom drawings

Subsequently, in 1902 he devised a conception in which cubic atoms can bond on their sides to form cubic-structured molecules.[12] In other words, electron-pair bonds are formed when two atoms share an edge. This results in the sharing of two electrons. Similarly, charged ionic-bonds are formed by the transfer of an electron from one cube to another, without sharing an edge. An intermediate state where only one corner is shared was also postulated by Lewis. Hence, double bonds are formed by sharing a face between two cubic atoms. This results in the sharing of four electrons.

Several years later, between 1913 and 1915, while working as the chair of the department of chemistry at the University of California, Berkeley, Lewis read an interesting paper by Harvard graduate student Alfred Parson who was visiting Berkeley for a year. In this paper, Parson argued that the electron might be a ring of negative electricity spinning with a high velocity about its axis and that a chemical bond results from two electrons being shared between two atoms.[13] In efforts to improve upon the Bohr model of the atom, Parson developed and even experimented on a model of the atom where the electrons were not point-sized particles that orbit around the atomic nucleus. In Parson's atom, the electrons in the shells surrounding the nucleus were 'rings of charge', with the shape of a toroid or donut. Since the electrostatic charge at the surface of the these rings is rotating, each electron is a tiny magnet.[14] This perspective, according to Lewis, meant that bonding occurred when two electrons formed a shared edge between two complete cubes.

Stimulated by this paper, Lewis wrote his famous 1916 article 'The Molecule and the Atom', in which the now famous *Lewis dot structure* was introduced to

represent atoms and molecules, where dots represent electrons and lines represent covalent bonds. Moreover, Lewis proposed that an atom tended to form an ion by gaining or losing the number of electrons needed to complete a cube. Lewis structures showed each atom in the molecule using its chemical symbol, in which lines drawn between connected atoms indicate that are bonded to one another; occasionally, however, pairs of dots are used instead of lines. Excess electrons that form lone pairs are represented as pair of dots, and are placed next to the atoms on which they reside. This method is currently taught to students in modern times. To summarize his views on his new bonding model, Lewis states:[15]

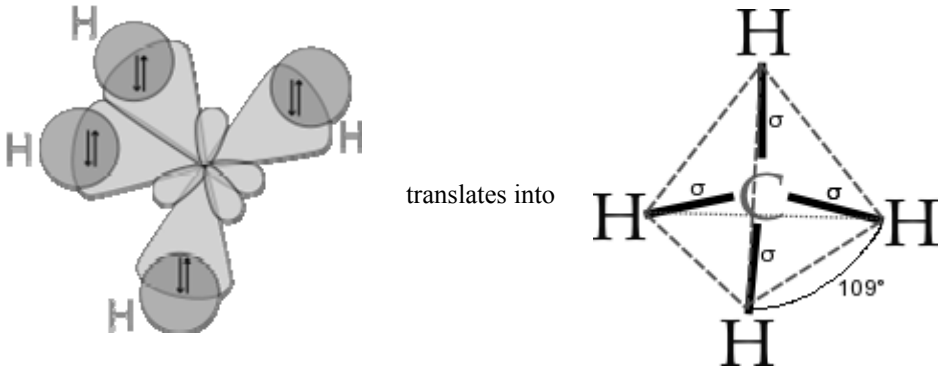
> “Two atoms may conform to the rule of eight, or the octet rule, not only by the transfer of electrons from one atom to another, but also by sharing one or more pairs of electrons ... Two electrons thus coupled together, when lying between two atomic centers, and held jointly in the shells of the two atoms, I have considered to be the *chemical bond*. We thus have a concrete picture of that physical entity, that ‘hook and eye’ which is part of the creed of the organic chemist.”

The following year, in 1917, an unknown American undergraduate chemical engineer named Linus Pauling was learning the traditional Descartes’ hook-and-eye bonding method at the Oregon Agricultural College, which was the basic description of bonds between atoms at the time. Each atom had a certain number of hooks that allowed it to attach to other atoms, and a certain number of eyes that allowed other atoms to attach to it. A chemical bond resulted when a hook and eye connected. Pauling, however, wasn’t satisfied with this archaic method and looked to the newly-emerging field of quantum physics for a new method.

Subsequently, in 1928, building on theories found in Lewis’ famous article, Pauling announced the preliminary findings of his upcoming article ‘The Nature of the Chemical Bond’, in which he used probability theories of quantum mechanics to calculate properties and structures of molecules, such as angles between bonds and rotation about bonds.[16] Pauling went on to develop the atomic *hybridization theory* to account for bonds in molecules, in which the mixing of atomic orbitals to form new hybrid orbitals became suitable for the qualitative description of atomic bonding properties.

The concept of ‘orbital hybridization’ is useful in the explanation of the shapes of blended molecular orbitals. In the methane molecule CH_4, for example, four sp^3 hybridized orbitals, i.e. tetrahedral dumbbell-shaped orbitals, overlap with four hydrogen’s *1s* circular orbitals, yielding four sigma (σ) bonds or tube-shaped

orbitals. The four bonds, subsequently, are equal in length and strength, thus yielding a correct molecular structure:[17]



Orbital and geometric bond structure of methane CH_4

Basic atomic orbitals, according to these views, to review, configurationally exist in a specific number of basic shapes. In an atom, the first two atomic orbitals closest to the nucleus are spherical shaped and are called s-orbitals. The next set of atomic orbitals, going outward from the nucleus, are three dumbbell-shaped electron orbitals called p-orbitals. In larger atoms, the outer electron orbitals are shaped as donuts and other advanced hybrid shapes.[18] Using this preliminary outline, we will now formulate the concept of the human molecular orbital.

Human molecular energy quantums

Let us now leverage this history to crack open an even more profound concept, the human molecular orbital structure. Using firstly the basic Feynman diagram human particle modeling scheme, and secondly the conception of molecular bubbles, as outlined previously, we can formulate the concept of *human molecular orbitals*. In quantum chemistry, an atomic molecule orbital is technically defined as follows:

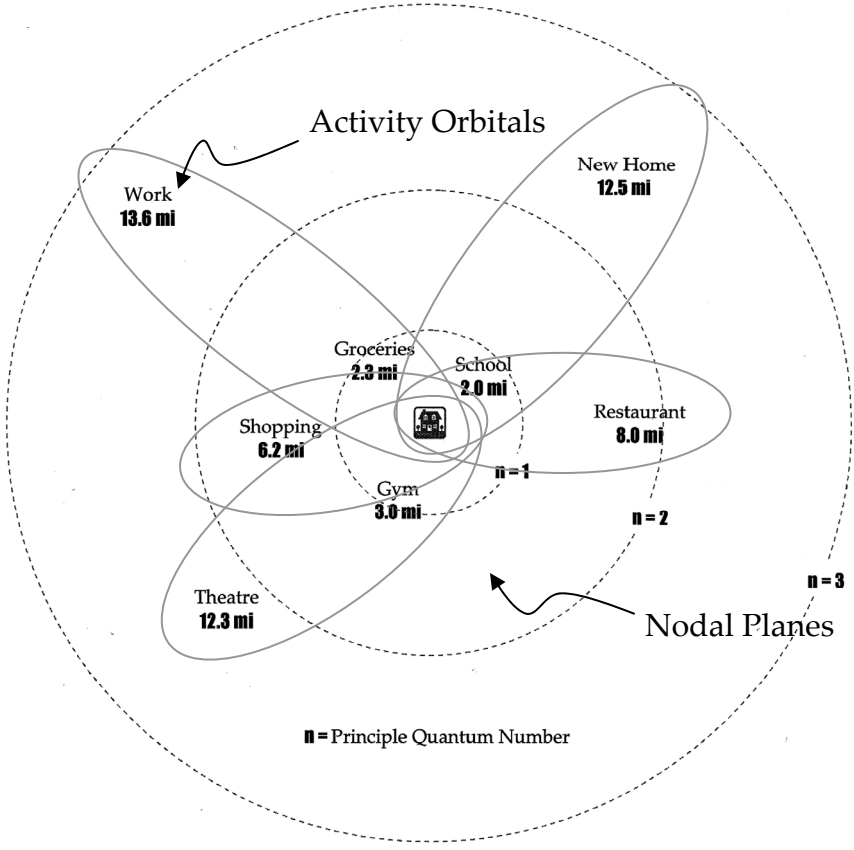
> **Molecular orbital** – a solution of the Schrödinger equation that describes the ninety percent probable location of an electron relative to the nuclei in a molecule and so indicates the nature of any bond in which the electron is involved.[2]

On this basic definition, we will model the external, spatiotemporal, i.e. space-time shape, of the human organism, i.e. human molecule, according to what are called 'human molecular orbitals'. If we watch the movement patterns of the human point mass, i.e. human body, as it moves about during the course of its day, we find that it moves in very specific activity orbitals, which have a probabilistic nature. It should

be noted that probabilities in science are not perfect, but they yield reasonable approximations of physical systems.

To give an idea of the typical human molecular *activity orbitals* used by the average person: during any average day in 2004, days being averaged over a seven-day period, persons in the U.S. age fifteen and over slept about 8.6 hours, spent 5.2 hours doing leisure and sports activities, worked for 3.7 hours, and spent 1.8 hours doing household activities. The remaining 4.7 hours were spent in a variety of other activities, including eating and drinking, attending school, and shopping. By comparison, persons employed full time who worked on an average weekday spent 9.2 hours working, 7.5 hours sleeping, 3.0 hours doing leisure and sports activities, and 0.9 hours doing household activities. The remaining 3.4 hours are spent in other activities, such as those described above.[19]

In terms of spatial distributions, a 1999 study conducted in ten major cities from around the England, Scotland, and Ireland areas regarding the typical daily movement patterns and average travel distances to activities proximal to one's home give and idea of how far the average person travels in relation to distances from one's home or nucleus. These results are shown below.[20] In this spatial diagram, for example, we see that the average distance a person will travel to purchase a new home, which is a form of substrate attachment relocation, on average, is 12.5 miles:



This spatial movement diagram shows the mean distances traveled by the average human body, i.e. human molecule, in the United Kingdom. It details the averaged topographical distribution of leisure, shopping, school, dining, living arrangements and activity movement patterns, etc., in relation to one's home. The non-traversed regions are technically called *nodal planes* (zero probability of travel).

Hence, analogous to basic atoms, we see that human molecules tend naturally to arrange the structure of their lives, or movement patterns, into concentric rings of stability about the nucleus of the family, i.e. the home. This is similar to how a positively charge nucleus arranges the movement patterns of its negatively charged electrons into concentric rings of stability about the atomic core. Again, both atoms and humans are comprised of the exact same components, namely protons, neutrons, and electrons. Having similar stability patterns should be a natural consequence.

In this diagram, n is value called the *principle quantum number*, which can have positive integral values of 1, 2, or 3, etc., and functions such that the diameter of the orbit of the human molecule, in its different quantum states, is proportional to n^2. In general, the distance one is willing to travel to a location, such as a store, a movie theatre, an occupation, a friend's house, etc., directly correlates with the potential energy stability value of that bonding interaction. The quantum numbers shown in the above diagram are found at radii of 3, 9, and 15 miles, respectively; and are only rough approximations. These preliminary quantum dimensions, however, provide a molecular geometric framework for the concept of the *nuclear family* or bonded unit of two parents plus one or more children, a popular term coined by American anthropologist George Murdock in his 1949 book *Social Structure*.

In 1900, Planck showed that the working body, i.e. atoms and molecules, of a thermodynamic system, can theoretically be divided into discrete energy elements in a manner similar to the statistical argument behind Boltzmann's entropy formula [8.7]; these energy elements later evolved into the conception of quantum orbitals. Building on this, in 1905 Einstein showed that the structure of the energy that a working body emits is comprised of discrete quantities, or light quanta. Tying this all together, in 1913 Bohr showed that when a working body emits or absorbs quantums of energy, that these 'forces' result to change the position of the electron in the sets of quantum orbitals in the atoms and molecules comprising the working body. These electron movements, subsequently, force the atoms and molecules of the working body into an 'evolution state', along the lines of the retinal molecule photon interaction.[21] In this state, the atoms and molecule of the working body will be out of dynamic equilibrium in their system, and as such will tend to move or re-organize their constituent positive and negative particles, i.e. nuclei and electrons, in relation to the bodies around themselves so to achieve a new stability.

In human reaction life, the working bodies are comprised of constituent human molecules and it is in this manner that these basic quantum principles apply equally to the human molecular situation. That is, human molecules will only emit or absorb

energy in certain discrete quantities. A representative measure of quantum in human molecular life is firstly the amount of work energy expended, per day, per activity, per orbital. Other ways to gauge the human energy quantums include the measure of a person's yearly salary as well as amounts of energy expended in system working activities, such as child bearing and raising or energy expended in volunteer work, community service, or social activities, etc. Dividing the totality of human life into quantums and energy elements, however, is a very difficult but not impossible task. There are many complicating factors involved in determining where specifically people utilize their personal quantums and how these expenditures or absorptions of energy effect human orbital movements. The first scientists to theorize along these lines were the energy psychologists of the late 19th and early 20th century, a branch of science that developed into the modern field of psychodynamics.

Psychodynamics

In psychology, *psychodynamics*, also known as 'dynamic psychology', is the study of the interrelationship of various parts of the mind, personality, or psyche as they relate to mental, emotional, or motivational forces especially at the unconscious level.[22] In short, psychodynamics studies the dynamic transformations, exchanges, and conservations of mental or psychological energy within the personality.[23] Psychodynamics attempts to explain or interpret behavior or mental states and the working aspects of life resulting therefrom in terms of family dynamics and external social forces as these effect innate emotional forces or processes.

The concept of 'psychodynamics' was seeded with the 1874 publication of *Lectures on Physiology* by German scientist Ernst von Brucke who, working in coordination with Hermann von Helmholtz, one of the central founders of thermodynamics, who was instrumental in the development of both the first law of thermodynamics and the concept of chemical free energy, supposed that all living organisms are energy-systems governed by the principle of the conservation of energy. During this year, at the University of Vienna, Brucke was also coincidentally the supervisor for first-year medical student Sigmund Freud who naturally adopted this new 'dynamic' energy physiology.[24]

Freud soon began to apply the first and second laws of thermodynamics to the process of mental life, especially at the unconscious level. Freud theorized that the human psychological life has three distinctive and interacting parts and he used thermodynamics as an extended metaphor to explain this. Using this tripartite division, in 1923 Freud published the ground-breaking book: *The ego and the id* in which he named these three distinctive parts, the id, the ego, and the superego:

1. The *id*, Freud described as our biological needs and drives, as: hunger, thirst, and sex, etc. The id provides energy for the system just as fire provides energy in thermodynamics.

2. The *superego*, Freud explained as society's rules, our voice of conscience. In thermodynamic terms, the superego would be a lid on the apparatus that contained water, which was to be converted into steam.

3. The *ego* is the conscious mind that contains one's thoughts, judgments and memories. In Freud's thermodynamic metaphor, the ego was the wheels and the escape valves where the steam is released.

The central premise of psychodynamics, according to Freud, is based on the first law of thermodynamics, which states that the total amount of energy in any system under study, which undergoes any transformation or process, is conserved. In translating this physical law into a psychological concept, Freud and others such as Alfred Adler, Carl Jung, and Melanie Kline, hypothesized that significant life experiences, especially early childhood experiences, in theory, are conserved in the unconscious. Subsequently, conserved experiences later in life must either remain buried in the mind or find their way to the surface, i.e. the 'conscious' level. This dynamic, in the former case, results in psychological states as neurosis and psychosis.

Soon other psychologists, being directly influenced by those as Brucke, Freud, and Helmholtz, began to develop similar psychological energy use theories, modeled on the laws of thermodynamics. In 1898, German psychologist Nicolas von Grot stated that 'the concept of psychic, i.e. psychological, energy is as much justified in science as that of physical energy, and psychic energy has just as many quantitative measurements and different forms as has physical energy.'[25] In 1915, in efforts to reconcile the conservation of energy, otherwise known as first law of thermodynamics, with quantum mechanics, and the energetic aspects of human life, German psychologist Oswald Külpe stated fascinatingly that:[26]

> "It would thus make no difference whether a *quantum of mental energy* inserts itself into the course of material process or not: the law of the conservation of energy as formulated hitherto would not be impaired."

Likewise, Swiss psychiatrist Carl Jung, who agrees with the above views, states in his 1928 article 'On Psychic Energy' that to frame an energetic point of view in psychology, i.e. to map mental events and efforts in a thermodynamics perspective, would be highly difficult because in trying to fit psychological energy processes into the framework of a physical system 'we have at best only the vaguest conjectures to go on and no real point of departure.' Moreover, Jung states 'although it seems

certain to me that psychic energy is in some way or other closely connected with physical processes, yet, in order to speak with any authority about this connection, we would need quite different experiences and insights.'

In his article, Jung cites von Grot as a pioneer in the field of psychophysical energetics, and outlined von Grot's founding *three principles* concerning the basics of human psychological energies, which are:

1. Psychological energies possess quantity and mass, just like the physical energies.

2. As different forms of psychological work and psychological potentiality, they can be transformed into one another.

3. They can be converted into physical energies and vice versa, by means of physiological processes.

Using these postulates, Jung asserts that the energetic standpoint in psychology can best be quantitatively measured on a subjective system of *values*. In Jung's view, the psyche posses an extraordinarily well-developed evaluating system, which he labels as 'the system of psychological values'. As such, according to Jung, 'values are quantitative estimates of energy.'[27]

This value as a function of energy theory will serve as a starting point herein. In short, it is reasonable to postulate, along the lines of Jung, that by attributing value to a person, place, thing, objective, or movement, etc., that the energy associated with this personal value or with the physical work expended in relation to this value, will correlate directly with a quantum mechanical energy stabilizing effect in that system. This is similar to Bohr's 1913 evolving molecular system *configuration postulate*, where he outlined the view the geometry that will be adopted by a system of atoms and molecules will be that in which the total energy for all the electrons in that system is a minimum.[28]

Hence, for example, when a person assigns a 'value' to an occupational label, we should expect the energy associated with or expended by virtue of this label will correlate with an energy lowering effect in reference to that person in the structure of their system. Conversely, if one begins to assign little or no value to a relationship, one can assume that, in some way, the relationship is in conflict with Bohr's configuration postulate. These emissions and absorptions of energy quanta, in the form of units of income, cost, energy expenditure, tensions, productivity, etc., will correlate, over time, to upwards or downwards movements, on a person's psychological ladder, e.g. a corporate ladder, social standing ladder, or peer-respect ladder, etc., or in orbital shells, and hence in principle quantum number.

Generally, the value of n determines the energy of the orbital. In chemistry, the principle quantum number also relates to the average distance the electrons travel in

each of the associated orbitals away from the nucleus. The larger *n* is, the greater the average distance of an electron in the orbital from the nucleus and therefore the larger, more energetic, and less stable the orbital.[29] Said another way, when a atom emits quantums, it forces the valence electrons to contract inward, over time; in the opposite sense, when an atom absorbs quantums, it forces the valence electrons to expand outward, over time. We should expect this pattern to hold true in reference to human molecular valence electrons, on average, over time.

In human terms, a person over their life reaction course will expend or release quantums of work energy, which, over time, will force the valence electrons of that person's molecular body to contract inward into a stable retirement orbital. To give one example, in the U.S., newly-minted MBA consultants tend to be fairly well-paid, comparatively.[30] For a junior-level business consultant, however, work locations tend to be sporadic and typically spread out all over the country and some cases around the world. Hence, work orbitals here tend to extend outward for many hundreds of miles. If, however, a junior-level consultant expends a certain quanta of energy in the form of work, over a set number of years, he or she will likely then be promoted or transferred into a more stable, centrally located, home-office (work-orbital), in such a manner to then function as a stable senior-level consultant.

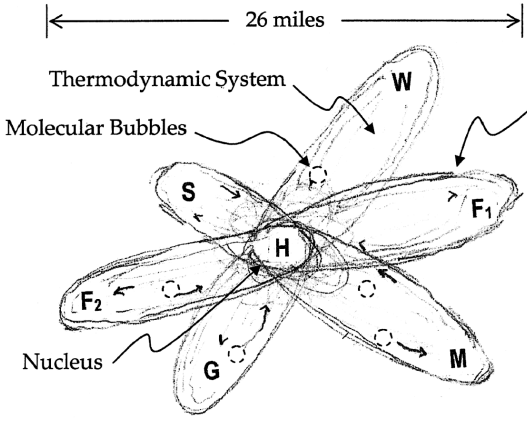
In sum, life can be divided up into energy elements. In particular, the dynamics of life can be gauged by exchanges of energy quantums and the interaction of both of these elements function to create human molecular orbitals, which are composed of electrons and nuclei and driven by a surrounding photonic field.

Human molecular orbital structure

Using the aforementioned logic, we will now formulate the basic model of a human molecular orbital. In short, structured over the historical framework of classical molecular orbital theory, in coordination with Howard's animal territories (1920), the propinquity effect (1950), Hediger's animal spacing / reaction models (1955), Hall's spheres of personal space or reaction bubbles (1966), the United Kingdom topographical distribution data (1999), and the U.S. Department of Labor American time use survey (2005), as a basis, and neglecting non-traversed regions, called *nodal planes*, we have, as shown below, what is called human *molecular orbital resolution*, in which the set of orbits shown represent the 90% probability region of the human molecule's dynamic or spatial movement patterns averaged over time.

In orbital resolution, time-averaged, dynamic movement patterns of the human point-mass, i.e. one human molecule, visualized as a dot, surrounded by personal space reaction bubbles, each varying in size, can be satellite-tracked, mapped, and computationally-choreographed over the typical day, week, month, year, or decade, etc., to obtain averaged probabilistic activity orbitals. Moreover, current technology is so advanced, that for as little as five-hundred dollars one can buy personal-sized

global GPS-tracking devices that, using wireless Internet communication, can secretly keep track on anything that moves.[31] Similarly, in 2007, as mentioned, shoe companies have begun to incorporate GPS-tracking technologies.[32] These tracking devices can report on speed, distance traveled, and can store daily activity and movement patterns for months at a time:



Symbol	Definition
H	Home
W	Work
F_1	1st Friend's House
F_2	2nd Friend's House
M	Mall
G	Grocery Store
S	School

Human Molecular Orbital

This orbital modeling scheme, essentially, is based on molecular orbital theory, which, as mentioned, is a method in chemistry in which the electrons of the molecule are not assigned to individual bonds between atoms, but are treated as moving under the influence of the nuclei in the whole molecule.[2] The molecule, as a whole, is defined to have a set of molecular orbitals. The total set of molecular orbitals defines the spatiotemporal external shape of the molecule. According to this perspective, we tend to find a high density of movement (mass) concentrated near to the *nucleus* (home) of the human-molecule.

Nucleus – the denser usually central portion of any association of matter.

The external shape of the 26-element human molecule is defined by the combined probability regions of distinctly-oriented human molecular activity orbitals. In particular, each separate activity orbital, such as a looped path to and from a friend's house, constitutes a probability region, wherein the human point mass will be found according to a specific probability, e.g. 15 percent of the time. The sum of all human probability regions will constitute the total human molecular orbital, in which the bound state human molecule will tend to be found 90 percent of the time.

At this resolution, subsequently, the typical human molecule has an average diameter of twenty-six-miles.[33] How can this be? In other words, how can a person be a twenty-six-mile wide molecule if he or she is only about 5'8" tall and no more than about six-feet in diameter? To resolve this confusion, we note, according to standard chemistry dogma, that this is how we have traditionally defined the shapes

of atoms and molecules. The 'total' area of a molecule's structure is the region in which its components, i.e. protons, neutrons, and electrons, are found according to distinctly specified mathematically predictable areas. In chemistry, these areas are determined according to quantum probabilities.

To illuminate this picture, let's recall when in 1907 the British physicist Ernest Rutherford was interested in trying to discover the structure of the atom, the basic component of any molecule. Rutherford began by firing α-particles, which are positively charged energetic entities comprised of two protons and two neutrons, into thin sheets of gold foil. What Rutherford found was that the majority of the α-particles either passed through the foil un-effected, or were slightly deflected. This fact indicated to Rutherford that most of the atom was essentially 'empty' space. Every now and then, however, an α-particle actually bounced back; meaning that, in the vastness of this 'open space', found within the atom, there existed a discrete compactness of positively charged mass, i.e. its nucleus.

In the human molecular case, just as in the vast 'openness' of one's territorial range, i.e. a person's activity orbital spheres, there exists a discrete compactness of mass, i.e. the physical body of the person or, as discussed in the last chapter, the point-mass of the human molecule. To quote Rutherford's initial reaction to his discovery: 'it was as incredible as if you had fired a 15-inch shell at a piece of tissue paper and it came back and hit you!'

By analogy, one can fire a 9-millimeter handgun through many-a-neighborhood (orbitals) in this world without getting much reaction. But if a person's home is hit, i.e. someone's nucleus, there will likely be a great response: return gunfire or police involvement. To repeat again, most of the structure of an atom or molecule is actually open space. Related to this theory, for two molecules, human or otherwise, to be bonded they don't actually have to be 'touching', but rather only held together in *mutual association* (spatial proximity) via hybridized or synergized functional (working) orbital-overlap. Atomic and molecular orbitals hold together whenever the attraction-to-repulsion ratios, resulting from field particle interactions and exchanges, function to be stabilizing; at a 5:1 ratio in the human case.[34] In other words, for a bond to hold, orbitals need to have a certain amount of constructive, synergistic, work-functioning overlap.

In sum, when a human being is viewed as a particle, exchanges between human particles result to transmit the force of interaction. These forces result to actuate the movement of the effected human particles in distinct regions of probability. These regions can be considered to be molecular orbitals. Whenever orbitals between two or more human molecules interact such as to facilitate an energy lowering effect in the system, we say that a chemical bond has formed.

Transition state theory

Related to molecular orbital models is *transition state theory*, i.e. a visualization of chemical reactions, or other processes involving the rearrangement of matter, as proceeding through a continuous change or 'transition state' in the relative positions and potential energies of the constituent atoms and molecules.[35] The theory of chemical transition states was developed in 1931 by Mexican-American theoretical chemist Henry Eyring and Hungarian–British polymath Michael Polanyi, following their development of the construction of potential energy surfaces for chemical reactions, which was initially applied to hydrogen atom and hydrogen molecule reactions.[36] In 1955, American organic chemist George Hammond successfully applied this theory to the description of organic reactions.[37] Hammond postulated that:

> "If two states, as for example, a *transition state* and an unstable intermediate, occur consecutively during a reaction process and have nearly the same energy content, their interconversion will involve only a small reorganization of the molecular structures"

This postulate was originally published in the *Journal of the American Chemical Society*, a paper that ranks among the 125 most cited in JACS history.[38]

The transition state, also called the 'activated complex', is the association of the atoms and molecules of the highest energy configuration during a chemical reaction. The transition state can be regarded as a short-lived intermediate that breaks down to give products.[2] In an typical S_N2 *substitution* reaction, for example, one atom or group approaches the molecule as the other leaves.[39] The transition state, in this case, is an intermediate state in which both *approaching species B* and *leaving species A* are partly bound to the molecule *R*, such as shown below:

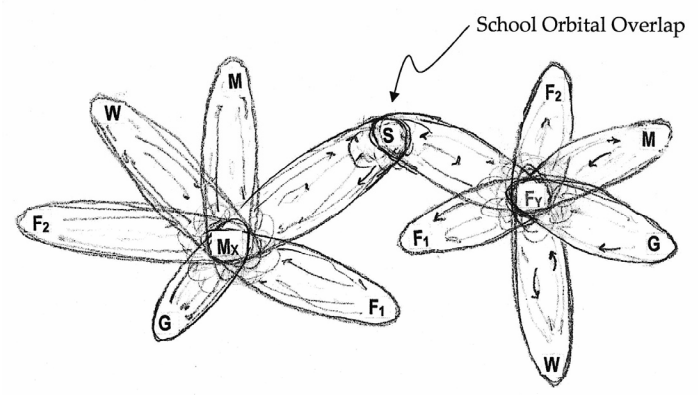
$$B + RA \rightarrow B\text{---}R\text{---}A \rightarrow BR + A \qquad [9.3]$$

In the theory of reaction rates, the reactants are assumed to be in equilibrium with this activated complex, which decomposes to the products. In the human case, [9.3] could represent the typical reaction in which a spouse cheats on his or her mate. Molecular species *R*, for example, might be a man weakly bonded to his wife *A*, i.e. the leaving species, in which *B* is a single woman, i.e. the approaching species, with which the man has an affair. During the heightened transition state, the man would energetically be bonded equally to each woman, in the form of an activated complex *B---R---A*. These types of situations, however, are short-lived and in many cases divorce may follow in which the man completely debonds from his wife, thereby

forming a new relationship with woman *B*, in the form of a new dynamically stable dihumanide molecular structure *BR*.

Transition state theories, as seen, easily apply to human chemical reactions. In this direction, human molecular orbitals will be employed to further detail the step-by-step process of the transition state of a typical human chemical reaction in mechanistic terms. In chemistry, a *reaction mechanism* is the step-by-step bond changing sequence in a basic reaction by which overall chemical change occurs.[40] This, essentially, is a dynamic visualized of the specific bonding or orbital changes associated with molecular reconfigurations. Human molecular orbital theory thus facilitates the study of the mapping process of the transition state of the typical human chemical reaction, for example, where a man *Mx* meets a woman *Fy* and they react, bond, and fall in love.

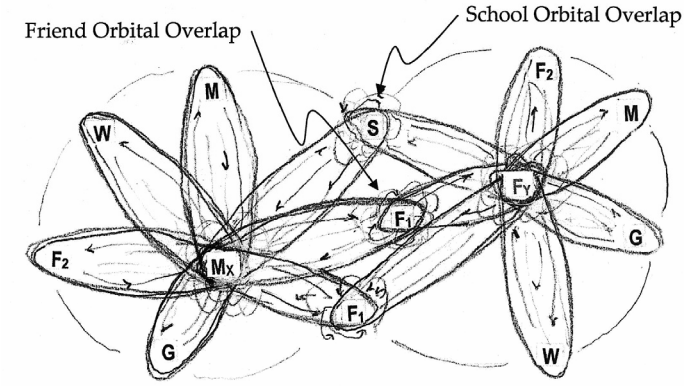
The first step in the typical reaction process is *activity orbital overlap*, i.e., for example, suppose two people attend the same educational facility, in which case their school orbitals *S* would overlap as shown below:



Human Molecular Orbital Interaction

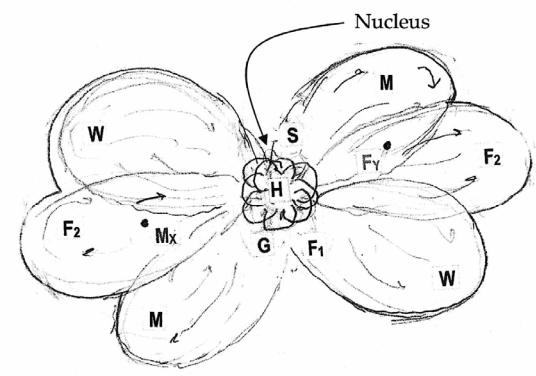
To elaborate on this picture, according to polled opinion the primary locations or places a husband and wife might first meet each other are work, school or college, a bar, happy hour, through mutual friends, at a party or social gathering, church, a club, a wedding, the gym, the grocery store, the internet, on the street, etc., respectively, as well as several other common locations.[41] In other words, these are the common activity orbitals a pair of human molecules, on average, might first begin to bond or interact.

Next, if interactions in the first orbital are favorable, the two human molecules might begin to show more advanced orbital overlap. Suppose, for instance, they start hanging out at each other's friend's houses. This would result in even more bonding, as shown below, where we see both friend, F_1 and F_2, and school *S* orbital overlap:



Enhanced Human Molecular Orbital Interaction

In continuation with this example, if our molecules in question were to continue in such an energetically agreeable direction, then next we might begin to observe a reaction step that we can define as *nuclear unification*, i.e. their spatially separate nuclei would merge to form one joint nucleus. In other words, two separate homes would unite to form one home or single living arrangement. In chemistry, nuclear bonds are typically stronger than distal bonds; as such, a move, depending on the thermodynamics of the circumstances, would usually accrue to the benefit of greater stability. There is, however, the oft-quoted related fact that those who live together prior to legal marriage, tend to divorce more often. This pattern might be more to do with a lack of spontaneity (caution or ambivalence) rather than orbital effects. In any event, a human molecular nuclear unification step would look like:



Human Molecular Nuclear Unification

In this diagram, we have a depiction in which two attached human molecules, *Mx* and *Fy*, are moving within the combined orbital of their joint territory. The energetic composition of the attachment here is a human chemical bond. To elaborate on this, according to evolutionary psychology and physical attractiveness research, humans tend to bond at twelve dominate points of adhesion, which can be further subdivided

into seven physical attachment points and five mental or neurological attachment points.[42]

Herein, as will be discussed, in human chemical bonds enthalpy properties will be mathematically correlated with physical attachment and entropy properties will be mathematically correlated with mental or neurological attachment. The seven basic physical attachment points typically found in human chemical relationships and their correlative enthalpy components are shown below:

Physical Attraction Attribute	Symbol
Averageness	H_{AVG}
Age	H_{AGE}
Symmetry	H_S
Se**X**uality (testosterone-to-estrogen ratio)	H_X
Latitude of Development (immune system)	H_L
Fitness	H_F
Complexion	H_C

Similarly, the five basic neurological attachment points typically found in human chemical relationships and their correlative entropy components are show below:

Neurological Attraction Attribute	Symbol
Personality, Social Graces, Character & Dependability	S_P
Occupation, Possessions, or Money	S_O
Information, **I**ntelligence, Education, or Knowledge	S_I
Status or Prestige	S_S
Inner **N**ature, Values & Ambition	S_N

The justification for this division of interpersonal human bonding into two types of thermodynamic quantifiers is based on pre-existent models. In drug-receptor thermodynamics, as mentioned, it is known that both enthalpic and entropic effects determine binding affinity between associative molecules.[43] Here, similarly, we will postulate that binding affinity, between associative human molecules, will be

determined by enthalpic and entropic effects. The equations proposed to model these bonding effects, via free energy (working effect) measurements, are:

$$H = H_{AVG} + H_{AGE} + H_S + H_X + H_L + H_F + H_C \quad [9.4]$$

$$S = S_P + S_O + S_I + S_S + S_N \quad [9.5]$$

In short, as a first approximation, [9.4] and [9.5] represent the twelve human points of *value* being correlative to the thermodynamic terms "total" enthalpy H, i.e. the measure of the total system heat energy, and "total" entropy S, i.e. the portion of total system energy that is unavailable to do work. In more detail, each term, e.g. H_{AVG}, can be quantified further as detailed in the G{H,S} column of the 60-mate-trait table, chapter six. Combined, these summations yield a rough approximation for the total Gibbs free energy G of the system, being the instantaneous energetic measure of system's productive work output or evolution potential:

$$G = (H_{AVG} + H_{AGE} + H_S + H_X + H_L + H_F + H_C) - T(S_P + S_O + S_I + S_S + S_N)$$

With regard to the combined law of thermodynamics, where $G = H - TS$, this set of equations yield the change in the Gibbs free energy of the system ΔG, which is the measure of the functional or productive work output or free energy expenditure of the reactive system over the course of its evolutionary development or per Carnot cycle diurnal evolution relaxation window. Enthalpic H properties tend to be related to intermolecular heating effects, i.e. how physically 'hot' or 'cold' each molecule is for each other.[44] Entropic S properties, however, tend to be related to intermolecular organizational effects, i.e. how well two molecule 'click' together, as well as molecular ordering effects, i.e. how ordered or disordered a system becomes during the course of the reaction.[45]

On these views, both entropy and enthalpy have a direct mathematical relation to human beauty. In general, in physical terms, both on an individual perceptual basis and according to common opinion or polled general consensus, three strong characterizations of human physical beauty apply for all molecular body types, namely: *averageness*, *youthfulness*, and *symmetry*.[46] Averageness signifies those phenotypic traits best representative of the most stable genotypes, or for molecules in general, it signifies stable physical structures, with respect to the evolution of the system. Age or youthfulness is associated with vigor, flexibility, bounciness, smooth body surfaces, babyfaceness, etc., being associated with or representative of the half-life of the molecular species.

Symmetry, a natural attractor, is representative of the early morphological development of the individual. Many factors support the natural favoritism towards symmetry. Men tend to start their sex life three to four years earlier than lopsided

men. Female partners of symmetrical men enjoy orgasms in 75 percent of sexual encounters, as compared with 30 percent for asymmetrical men. Animal studies show that diseased mothers give birth to offspring that show greater asymmetries. From human studies, it is known that women with asymmetrical breasts are less fertile than those with greater symmetry.[47] Others have shown that bilateral symmetry is an important indicator of freedom from disease, and worthiness for mating.[48] Facial asymmetries and minor physical anomalies begin to appear early in embryonic development, mainly the first trimester of pregnancy, and can be a sign of instability during growth.

Sexuality, as can be discerned by testosterone-to-estrogen levels, is a dominant factor in human bonding. Aside from genetic determinants, following conception, intrauterine hormone levels determine a person's sexual development, e.g. his or her adulthood levels of masculinity or femininity. This creates a *spectrum of sexuality*, from high-testosterone men, through testosterone-estrogen middle mixtures, to high-estrogen women. People tend to bond with those whose levels match their own on the opposite end of the hormone scale, e.g. high-testosterone men tend to bond with high-estrogen women.[49]

The latitude of a person's development, as defined by their averaged ethnicity, is indicative of that person's immune system. Studies based on scent attractions and repulsions indicate that people are most attracted sexually to individuals with the most dissimilar major histocompatibility complex (MHC).[50] The MHC is a large gene-dense region that controls the immune system and plays a role in reproductive success. Immune system development, in turn, is dependent upon the location of development and heritage of person. Each environment, being quantified generally by latitude belts, molds the body, and hence the immune system, to be susceptible or resistant to different diseases. To cite a few examples, Northern European whites (50^{o}-65^{o}) are susceptible to cystic fibrosis, near equatorial African blacks and aborigines (0^{o}-35^{o}) are susceptible to anemia, Greeks, Italians, and Mediterraneans (35^{o}-41^{o}) are susceptible to β-thalassemia, Southeast Asians (10^{o}-30^{o}) and Philippines (5^{o}-19^{o}) are susceptible to α-thalassemia, and Ashkenazi Jews are susceptible to Tay-Sachs disease. Hence, owing to these immunity weaknesses, people will have a tendency to sexually select, i.e. be attracted to others, outside of their own latitude of heritage. Studies show that, on average, people tend to be physically the hottest for those ethnicities which differ from their own by ± 15º in latitude.[51] Lastly, fitness, being a general representation health, and complexion, indicative of certain diseases, both significantly effect physical bonding.

In terms of mental bonding, i.e. molecular neurological attachment points, e.g. personalities, intellects, characteristics, or viewpoints, etc., that click together nicely, entropy values function to quantify this facet of attachment. Entropic bonding can thus be thought of as a neurological heat. These include: personality, social graces, character, dependability, occupation, possessions, money, information, intelligence,

education, knowledge, status, prestige, inner nature, values, ambition, as well as numerous others. The mapping of these into actual mathematical functions that can be quantified is a more advanced topic in human chemical thermodynamics; one example, however, as discussed in chapter six, is the use of entropy quantifiers on mate selection free energy landscapes.

These evolutionary psychology mate attachment descriptors, subsequently, will be used as a basis to elaborate on bond composition. In this direction, knowing that the negative value of the change in the Gibbs free energy [4.11] for chemical reactions between people is the 'driving force' for those reactions, a point of view developed by Americans Gilbert Lewis and Merle Randall in 1923, we can postulate, as a first approximation, that human molecules, in their best unions, will tend to adhere through what is called an evolving *dodecabond*, which is characterized by the twelve points of electromagnetic adhesion as described in the above tables.[52]

In other words, at an approximation, if we assume that two people are reacting in a closed isothermal, isobaric system, meaning that the reacting system is at constant temperature and pressure and that no new reactive species are entering the system, e.g. a group of people at summer camp, or established species leaving the orbital boundaries of the confined lives of the reacting pair, and moreover that no external biasing forces, such as financial, occupational, friend, or family biasing factors, etc., are significantly effecting the decision processes of the pair, then we can correlate the mate-specific evolution energetics of the reaction, such as via [9.4] and [9.5], according to the Gibbs free energy equation [4.11]:

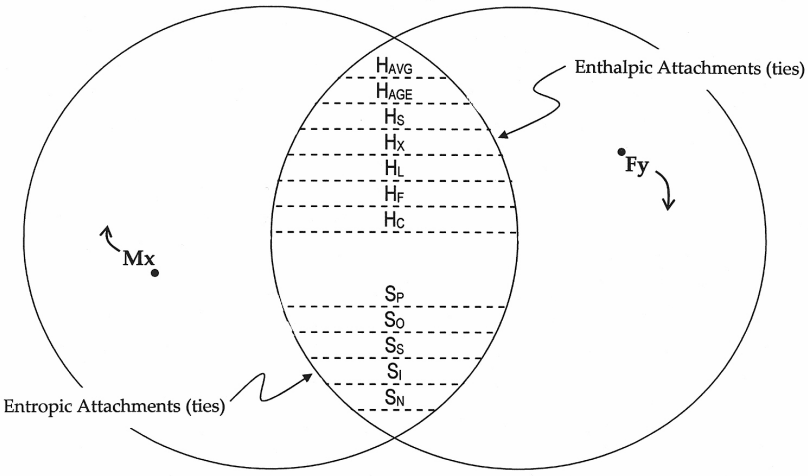
$$\Delta G = \Delta H - T\Delta S \qquad [4.11]$$

A spontaneous reaction will proceed, according to [4.11], when the change in the Gibbs free energy ΔG is negative. A more advanced analysis, of course, would take into account a number of related energy factors such as the existence of endergonic-exergonic coupling effects, in which weak reactions are driven by strong reactions, external forces X_i found to be working on the pair, such as social setting, family, or peer pressure, etc., the flow of other available reactive species η_i, into or out of the system, and the instantaneous nature of free energy changes dG. This type of treatment would entail the use of an equation of the form:

$$dG = PdV - SdT + \sum_{i=1}^{k} \eta_i dn_i + \sum_{k} X_k dx_k + \ldots \qquad [9.6]$$

The open-endedness of expression [9.6] leaves room for the possible inclusion of more advanced mathematical appendages found to be unique for each situation, used in such a manner so that both the first and the second laws of thermodynamics are satisfied completely. The direct application of [9.6] in human reaction scenarios is an advanced topic in human thermodynamics.

If we incorporate these basic thermodynamic descriptors into an orbital picture, meaning that we use enthalpy and entropy measures to facilitate the characterization of the typical chemical bonding composition between two people, and furthermore use orbital circles to depict the basic human activity region, we would arrive at the following chemical thermodynamic, time-enhanced, compositional diagram of human orbital bonding:



Do-deca-bond model

The 'dodecabond model' is derived similarly to the atomic-molecular conception of single (A-B), double (A=B), or triple (A≡B) bonds, etc., and their necessary relationship to thermodynamic stability and free energy, as first suggested by Lewis in 1916. In his famous article 'The Atom and the Molecule', Lewis uses nitric oxide *NO*, an inert, thermodynamically unstable, gas-phase molecule, having a bond type intermediate between that of a single bond and a double bond, as an example. Lewis first points out that normally nitric oxide is an extremely stable substance, but that it is thermodynamically unstable, and if it is made to react, such as by using a catalyst or high temperatures, that the free energy involved in its decomposition is enormous. Moreover, quite accurately, Lewis states that in the case of any molecule:

> "Thermodynamic stability is closely associated with the work of breaking some bond."

Thus, by extrapolation, in the human molecular case, the thermodynamic stability of any intimate relationship is closely associated with the work involved in breaking one or all of the twelve dominate courtship bonds. If, for example, a man looses his job, an entropy factor, or woman her looks, an enthalpy factor, there will result to be inherently little residual work, depending on the relationship, involved in breaking the remaining bonds. Conversely, if a pair remains strong at all twelve points of

adhesion, throughout the course of their reaction life, thermodynamic stability will result based on the fact that it would require an insurmountable amount of work to break the bond of union.

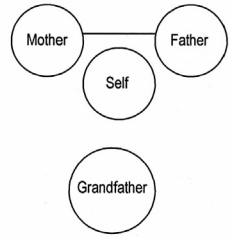
The dedecabond theory, to note, is another more advanced topic of discussion in human thermodynamics, which is based heavily on the mathematics of chemical thermodynamics. Using this basic twelve-function orbital model, however, we can, for example, satellite-track inter-molecular association distances, analogous to inter-nuclei distances in molecules, and in doing so determine time-averaged separations in which repulsions predominate, e.g. spending too much time with a person, as well as time-averaged separations in which attractions predominate, e.g. spending too much time away from a person, and in this manner find separations correlative to potential energy minimums, such as is done presently in quantum chemistry with smaller systems of nuclei and electrons. In outline, here we have a means to more accurately analyze close human bondings in what has previously been attributed to the simply effects of mental integrations, e.g. likes attract, and physical heats, e.g. sexual connections.

To elaborate, in 1996 American psychologist Ruthellen Josselson, in her book *The Space Between Us*, states correctly that attachment is a biologically and ethologically based need for bonding, which is grounded independently in the causal need to seek proximity to other people, through various channels, physical or otherwise. To understand better what people mean when the say that certain people are just ‘there’ for them, or that with certain others they feel their lives ‘intertwined’ in some manner, or that certain couples seem to have an impenetrable ‘shell’ surrounding them, etc., Josselson conducted a series of interviews with people where she asked participants to draw what she called *relational space maps*.

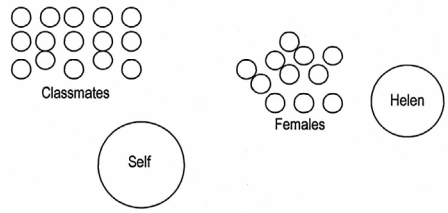
The rules for these maps are that each significant person in a stage of person’s life gets a circle with their name inside. Second, the distance between the circle of the participant to other circles on the page is drawn to represent their inner presence in the mind of the participant at that period life, rather than who was physically there, how far away they lived, or similar factors. Third, a ‘dotted circle’ was used to represent someone who mattered a lot to the participant at that time in their life, but who was not their at all as a physical presence, such as a deceased person, or someone thought about a lot even though there was no real interaction, or someone a person conversed with in their head. Fourth, smaller ‘group circles’ were used to indicate people who were important as a group but not on an individual basis, such as the swim team, or a youth group, etc. Lastly, participants were instructed to make drawings at five-year intervals beginning at age five.

Using this method, the relational space map was drawn by a man named Paul, interviewed by Josselson, for three stages of life, age 5, 20, and 30:

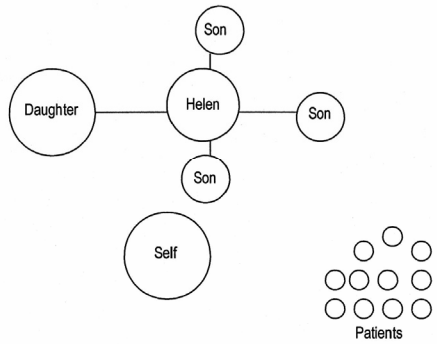
Paul: Age 5



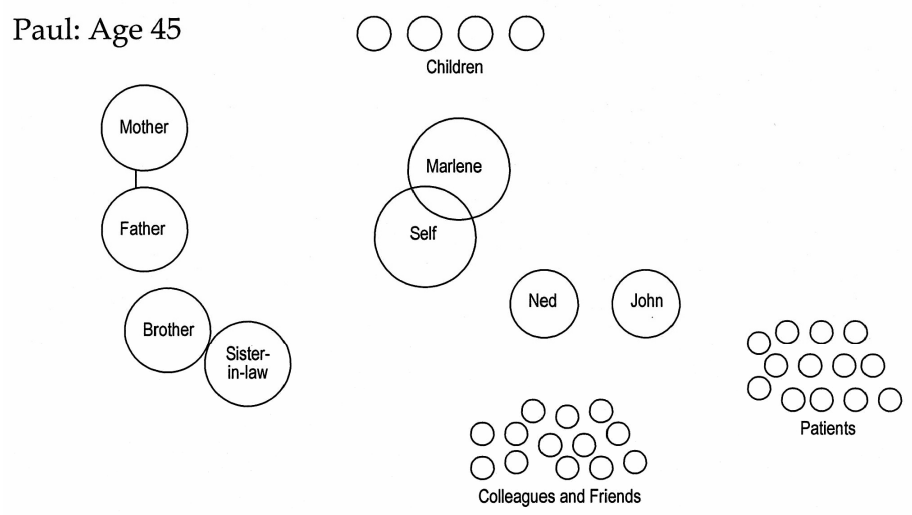
Paul: Age 20



Paul: Age 30



Here we see Paul using lines, possibly to signify a bond of some kind, as well as clusters to signify the group attachment effect, in which certain groups are depicted as being bonded closer to Paul. Notice also, that the size of each circle seems to relate to the significance of that person in Paul's perspective. Curiously, although he had four children with Helen, he seems to remain aloof, distant, or detached, in some way, from Helen. The next drawing shows Paul at age 45:



Here we see an entirely different picture. Paul seems to have detached from Helen completely, has many new friends and colleagues, has grown in his relationship with his immediate family, and seems to have incorporated a less-demanding or absorbing working relationship with this patients, as seen by an increase in bonding distance as well as the existence of intermediates, i.e. Ned and John, between himself and his patients. Most interestingly, however, we see Paul drawing intuitively what appears to be 'orbital overlap' with his new found bonding partner Marlene.

The same type of orbital overlap picture, similarly, is found on the cover of the 1982 book *The Sibling Bond*, by American psychologists Stephen Bank and Michael Kahn. Two overlapped orbital circles are used to represent the 'powerful emotional connections among brothers and sisters throughout life.'

It is here that we find a striking utility in the use of such theories as human molecular orbital overlap, dedecabond theory, chemical bonding, molecular clusters, etc. Moreover, what we see in Paul's last diagram are at least eight unique types of human chemical bonds, i.e. that between the mother and the father, between the brother and the sister-in-law, between the children, between Ned and John, between his colleagues and friends, between his patients, between Marlene and Paul, and the relation between Paul and each of these molecular units as a whole.

Orbital aspects of collision theory

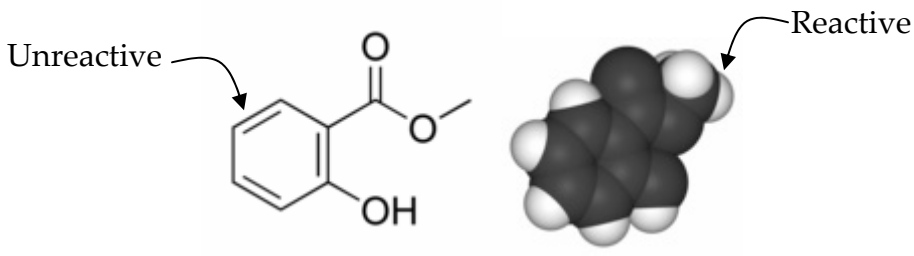
In chemistry, as mentioned, collision theory explains how chemical reactions occur and why rates of reaction differ. Human molecular orbital theory thus provides for a more accurate and updated visual perspective of collision theory, i.e. the theory that molecular collisions must precede chemical reaction. In addition to the energy and concentration of reacting species, molecules also have size and shape. When two

molecules collide, the respective 'shapes' of not only the physical bodies of those molecules, but also the probabilistic movement or dynamic lives of those collisional molecules will play a significant role in determining if the reaction is to be a successful one. The integration of molecular shapes boils down to a basic geometry of congruent or incongruent orbital overlaps, blendings, and orientations during the point of collision.

To visualize this correctly, understand that at an accelerated pace, e.g. such as when watching the high speed GPS-tracking simulation of person's lifespan, humans tend not to remain affixed to one location or attachment site on a permanent basis. High-speed photography of several months of plant growth, for instance, such as strawberry shoots, when flim clips are watched at once, clearly shows how plants seem to 'walk' across substrate, like slow moving pool table balls. A person, by comparison, is conceived in one location, born at another, raised at one or more residences, schooled at possibly four or more different institutions, occupationally attached to any number jobs or careers, follow changing friendship patterns numerous times, seek adjusting retirement locations, etc. In other words, when viewed at a sped up rate, a person's movement orbitals, on average, are continuously moving, re-configuring, migrating, and translocating over the surface of the earth, in a punctuated manner, in possession of a certain momentum and direction. Subsequently, the relative orientations of orbitals, predisposed in certain directions, according to certain energetic rules, will significantly affect the end outcome of reaction collisions.

If, for example, two people collide in their work orbitals, e.g. a man and woman begin to interact at a new job they both recently started; it would significantly help the progress of the reaction if they also live nearby each other and also coincidently engage in similar activities, such as belonging to the same chess club or knitting class, etc. Similarly, suppose two people, stemming from different locations, are simultaneously each leaving their hometown to attend the same state university; then a reaction between these two people would be highly likely if, for example, they both coincidently got the same summer job, attended classes near to each other on campus, and hung out at similar parties. Conversely, if these two unacquainted people never worked together, took classes in dissimilar locations on campus, and partied in different circles, then there would likely be no collision between these to human molecules and thus no reaction.

To give a second example, in chemistry certain sides of small molecules, such a methyl salicylate, $C_6H_4(HO)COOCH_3$, otherwise known as oil of wintergreen, a type of oil that is a natural product of many plants, may be occupied by rather unreactive atoms and on other sides by highly reactive ones:



Methyl salicylate ($C_8H_8O_3$)

Reactions, however, can only occur whey the reactive sides are involved.[53] In human terms, a person may be very reactive in their dance club orbital but docile in their library orbital. A collision with an unreactive side of a molecule is not nearly as apt to lead to reaction.

Conversely, a highly energetic collision may break a molecule apart regardless of the orientation at the time of collision, e.g. love at first sight may strike a patron amid the sociology stacks at the public library. The simplest correlation between collisional energy and geometrical orientation is to say that the activation energy E_A varies with the geometrical orientation of the molecules at the moment of collision.[53] Most theoretical approaches, however, treat the orientation problem merely in terms of the likelihood that a suitable orientation will occur during the collision. This likelihood is often quantitatively formulated as the *entropy of activation* ΔS_A, which may be expressed as:

$$\Delta S_A = R \log \frac{O_G}{O_T} \qquad [9.7]$$

In expression [9.7], R is the ideal gas constant, O_G is the number of good collisional orientations, and O_T is the total number of collisional orientations.[53] This ratio is often very much less than one. Thus as ΔS_A becomes more and more negative, i.e. as the value of ΔS_A decreases, the orientation requirements become more and more stringent. In human substrate terms, this could be, for example, someone with very high standards or a person with particular mate requirements. It could also refer to someone whose life orbitals are highly restricted, e.g. previous obligations, career objectives, children, or debts, etc. A less negative value of ΔS_A indicates that a wider variation of collisional configurations can lead to reaction. This could be someone who is more flexible in their dating requirements or someone who has more active dating orbitals or social orbitals available to them. In sum, the entropy of activation determines the fraction of molecular collisions that have the appropriate orientation, just as the energy of activation determines the faction of molecules that will have sufficient energy to react upon collision.

The orientation requirements may be very stringent with complicated molecules, i.e. large negative value of ΔS_A, and may lead to a very slow rate even though the

activation energy is low and the concentrations are high enough to insure many collisions.[53] These types of collisional situations could refer to, for instance, people restricted to an upper social class or those more elaborate in life structure having more contingencies placed on them. On the other hand, substances of simple shape will normally react very rapidly even at low concentrations, since they have small negative values of ΔS_A, if their energy of activation is low.[53] These types of collisional situations could refer to, for example, a person with little education or a lack of family structure. A high school dropout from a broken home may quickly get pregnant in her teens with her first boyfriend, whereas a socialite from an elite family may delay serious dating and pregnancy until a later time. In chemical terms, by comparison, silver chloride $AgCl$ precipitates fast as silver and chloride ions; both Ag^+ and Cl^- are spherical and simple. On the other hand, sodium acetate $NaCH_3CO_2$ supersaturates readily since the resulting crystal, sodium acetate, has a complicated structure due to the lack of symmetry in the acetate ion $CH_3CO_2^-$.

These entropy of activation formulations, to note, are generally modeled on gas or liquid phase reaction collisions. Somewhat less is known, however, about the details of reaction collisions in condensed phases, such as those in living systems, as compared to gas phases, but few new ideas seem necessary. The principle theoretical difference between reactions in gas phase systems as compared to reactions in liquid or condensed phase system, etc., according to chemist Arthur Campbell, from his 1965 book *Why Do Chemical Reactions Occur?,* seem to be attributed to 'the restricted motions that molecules experience in condensed phases … molecules tend to get trapped or caged in certain locations, and can only with difficulty force their way out toward reactive sites.' Nevertheless, according to Campbell, the basic principles of collision theory apply equally in the gas phase, condensed phase, and substrate phase, i.e. human reaction life, collisional scenarios.

In sum, according to basic collision theory, for a reaction to occur the reacting species, i.e. atoms or molecules, must collide. Only a certain fraction of the total collisions, however, cause chemical change; these are called 'successful collisions'. Successful collisions are characterized by having sufficient energy, i.e. activation energy, at the moment of impact to break the existing bonds and form new bonds, resulting in the products of the reaction.[54]

In human life, collision theory finds application at every turn of events; the pinnacle example being first love or first marriage. To exemplify this, when people fall in love, according romance researcher Diane Ackerman, from her *A Natural History of Love*, 'they break the tight bonds of kinship and leave their families to found a new family with its own bonds, its own values, its own country and kin.'[55] In other words, when the lives of two people collide during the process of love, not only do the two human molecules collide, but so to do the views of their extended families, friends, and associations, a factor which, in many cases, can either make or break a bond.

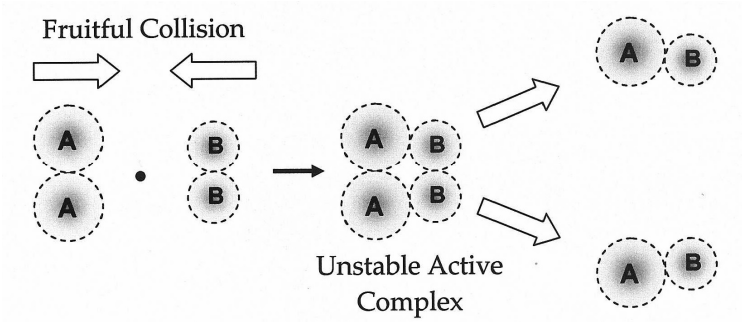
Relationship psychologist John Gottman uses the example of the turf battle that commonly erupts between the two dominant women in a man's life, i.e. his wife and his mother, in relation to tension situations such as, for example, choosing between his commitment to his wife's home-cooked meal as this conflicts with a previous commitment to dine out according to his mother's plans. Gottman finds that these types of critical decisions typically involve 'some rending and tearing away from the primary family' as the man bonds tighter to his new family unit. Conversely, a man may choose to side with his primary family, a decision that resultantly will tend to deteriorate the marriage bond.[56]

The reactions between Shakespeare's *star-crossed lovers* Romeo and Juliet is a typical example of this collisional effect. In this story, the famous adjective 'star-crossed', a term coined by Shakespeare, refers to destiny and the inevitability of the two paths crossing each other in an unlucky manner. In this case, the misalignment of social hierarchies functions to create an insurmountable energy barrier to the successful completion of the bonding process.

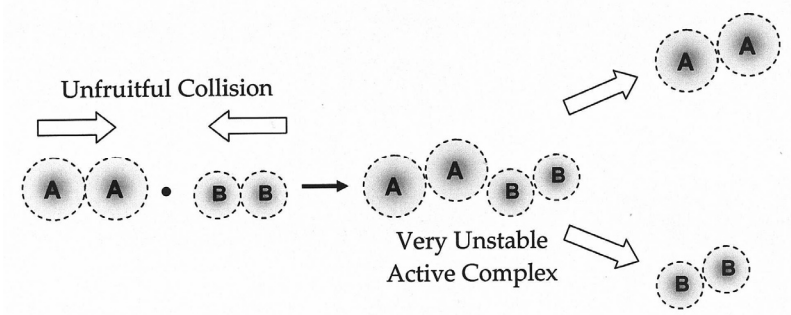
Fundamentally, collision theory is based on kinetic theory. In 1889, Swedish chemist Svante Arrhenius explained the fact that most reactions require added heat energy to proceed by formulating the concept of *activation energy*, E_A, an energy barrier that must be overcome before two molecules will react.[57] At a basis, this theory assumes that chemical species 'collide' prior to reacting. Moreover, with the development of the orbital theory in the early 20th century, it then developed the basic premise or postulate that the majority of collisions do not lead to a reaction, but only those in which the colliding species together meet the following two criteria:[58]

1. The total kinetic energy of their collision is greater than a certain minimum, called the activation energy, E_A.
2. The molecular orbitals possess the correct spatial orientation with respect to each other.

In other words, a collision in which the paths of two molecular species impact will be effective in producing chemical change if and only if the species brought together possess a certain minimum value of internal energy, equal to the activation energy of the reaction, and that the colliding species must be oriented in a manner favorable to the necessary rearrangement of atoms and molecules.[59] An example of a favored moving orbital orientation, in which both reactive orbitals meet head on, resulting in a successful collision, is shown below:



Similarly, the following diagram shows an example of a moving orbital orientation in which only one set of reactive orbitals meet head on, resulting in an unsuccessful collision:



In these examples, *A* and *B* could be, for example, a pair of friends, a person and his or her career, the location of an extended family member, etc. Referring specifically to interpersonal romantic relationships, a person will typically engage in a large number of potential dating interactions, i.e. collisions, before any one successful significant bond-forming reaction results. Through this process, chemically-speaking, a collision between molecules may or may not result in a successful reaction. The outcome depends on factors such as the relative kinetic energy, relative orientation, and internal energy of the molecules involved, etc. Even if the collision partners form an *activated complex*, i.e. a transition state dihumanide molecule, they are not bound to go on and form products, and instead the complex may fall apart back to the reactants, i.e. the molecular couple may break up.[60]

To explain the idea of collision between reacting human molecules, film studies professor Martha Nochimson, in her 2002 book *Screen Couple Chemistry,* analyzes the raw screen chemistry exuded from the pairing of Johnny Weissmuller, a miner's son and five-time Olympic gold medal winner, with Maureen O'Sullivan, an officer's daughter and finishing school debutante, in the famed MGM *Tarzan* series, during the years 1932-48. As Nochimson states, 'the powerful bond between Tarzan and Jane remains strong throughout the six films of the MGM series, but their relationship evolves as it is weathered and textured by the competing value systems

that their union brings into collision.' Weissmuller, according to Nochimson, brought a highly unusual physical beauty that was charged onscreen by an almost uncanny ease with physicality, and O'Sullivan brought her ingénue charm, petite elegance, and a splendid emotional openness and readiness. Once together, they were not interchangeable with other actors of their type, nor were their films disposable or dull, mechanical imitations of each other. In concert, Weissmuller and O'Sullivan amassed a riveting energy dynamic that paradoxically frustrated, decentered, and even inverted the studio plains for a controllable product at the same time that it eminently fulfilled studio plans for garnering substantial profits.[61]

Weissmuller being born in 1904 and O'Sullivan being born in 1911 would have put the pair in a reaction scenario in which the lives, or specifically the aligned 'work orbitals', of a 28-year-old male and 21-year-old female impacted favorably and synergistically, onscreen, through a human molecular combination reaction. The pairing or reaction held for a span of 10-years until 1942 where after O'Sullivan, fearing the possibility of being typecast, moved to other projects. When viewed at an accelerated pace, following the tendency of the combined law of thermodynamics towards reaction-partitioned evolution, we see a situation in which first, two human molecules were formed at their point of conception; second, over the course of two decades each molecule gathered potential, i.e. internal energy, and kinetic energy, through the process of raising oneself and seeking career paths or personal objectives; and three, via happenstance, the momentum of their lives collided in the jointly-desired project of filming.

Orbital applications

In a reaction, to review, the *reactant* molecules, e.g. two single human molecules, come together and chemical bonds are stretched, broken, and formed in producing the *products*, e.g. a bonded pair of humans. During this process the energy of the system increases to a maximum, then decreases to the energy of the products. The activation energy E_A is the difference between the maximum energy and the energy of the reactants, namely it is the energy barrier that has to be overcome for the reaction to proceed.[2] As a rule, the lower the activation energy the faster the reaction.[62]

Activation energy can also be defined as the minimum amount of energy that is required to activate atoms or molecules to a condition in which they can undergo chemical transformation or physical transport.[63] In other words, in the human case, to be in a transition state, a person needs to be in a energetic condition in which he or she is ready to undergo chemical transformation. If, conversely, a person is locked into a desired objective, a career, a fervent relationship, a number of friendships, etc., it will be unlikely that significant transformation will ensue; for this to occur each of these bonds would need to be stretched to their maximum near-break capacity.

The activation energy, according to transition state theory, is the difference in energy content between the atoms or molecules in an *activated complex* or transition state configuration and the corresponding atoms or molecules in their initial configuration. When molecules collide, some of their kinetic energy is converted into potential energy within the colliding molecules. If enough energy is converted, the old bonds become sufficiently distorted and the colliding molecules form an activated complex. New bonds can then begin to form. In this brief interval of bond breakage and bond formation, the collision complex is in a transitional state. In this state, established friendships will be noticeably different, residual family bonds may break off, and many newly formed attachments will likely assemble, such as new living arrangements, new friendships, and new jobs. Some sort of partial bonding exists in this transitional structure. The exact structure of this mid-reaction complex is often difficult to determine, but it is important in discerning the mechanism of a reaction.[64]

Using molecular orbital theory, we can now better understand the idea of human bonds stretching, reconfiguring, or distorting over the course of one's life. If, for example, two people, who work in nearby towns, collide during spring break, and then begin to react, but that at the height of their potential energy diagram, they feel stretched beyond capacity, e.g. trying to simultaneously hold on to their old life-style and their new potential reaction life, the pair may fall back to separate reactants. This can be explained orbitially by graphically drawing out the stretched orbitals and by detailing the amount of energy involved in each orbital, such as extra travel time, reduced friendship time, etc. If, conversely, two people meet over the course of a summer break and find out that they will be attending adjoined schools during the coming year, it is simple to show, using orbitals, how this situation factors out energetically in a more probability positive way.

The *transition state* can be regarded as a short-lived molecular intermediate that breaks down to give the products.[2] In human application, individuals found to be continuously or repetitively in the molecular transition state, with numerous short-lived relationships, are often categorized as being love junkies or, in general, 'life junkies' because they seem predisposed to engage in a million different things. The rate by which the final state is attained is determined by the number of activated complexes formed and the frequency by which they go over to the final state.[65] In human application, a couple may go through a number of 'activated complexes' in the transition state of their relationship before attaining the stability of a long-term relationship.

Another interesting application of the concept of human molecular orbitals and human molecular bubbles is in regards to that of the spatial distribution or position of different types of molecules in any number of various systems, such as gas phase, liquid phase, surface phase molecular systems. As we have shown, different human

and animal molecules have different sized molecular bubbles. Studies show that alpha males and alpha females are given more individual or personal space.

In chimpanzee troops, the lower ranking beta, gamma, or omega males show a distancing respect to the alpha of the community by ritualized gestures such as bowing, allowing the alpha to walk first in a procession, or standing aside when the alpha challenges.[66] Canines also show deference to the alpha pair in their pack, by allowing them to be the first to eat and, usually, the only pair to mate; wolves are a good example of this. The status of the alpha is generally achieved by means of superior physical prowess. In certain highly social species, however, such as the bonobo, a contender can use more indirect methods, such as political alliances, to oust the ruling alpha and take his or her place.

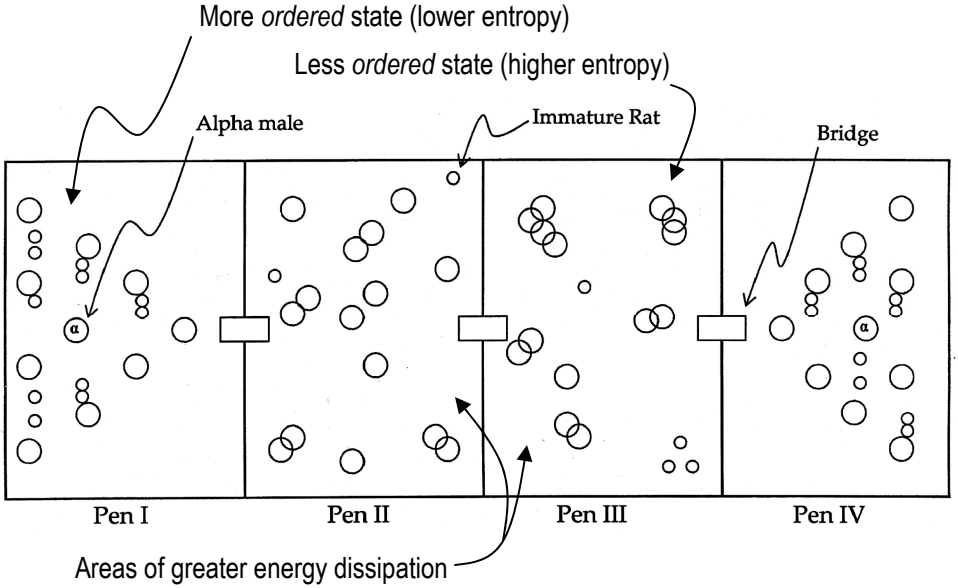
As a result of these noted variations in the sizes of interpersonal bubbles, we might reasonably postulate that in all molecular systems there exist alpha-molecules, beta-molecules, gamma-molecules, omega-molecules, etc., ranked by hierarchy, being spatially distributed, that as a result of variations in intermolecular attractions, function to create macroscopic phenomena such as pressure or density variations in gas, liquid, or solid phase systems.

In this direction, rat population dynamics and interaction behaviors provide for an exemplary model of molecular distribution tendencies. Rats can be approximated as 23-element molecules. Beginning in 1947, ethologist John Calhoun conducted a fourteen-year research project in which he studied the population dynamics of wild Norway rats, through multiple generations, confined to quarter-acre outdoor pens surrounding a barn in Rockville, Maryland.[67] In the first stage of his study, Calhoun introduced five pregnant rats into the outdoor pen, being well-stocked with food and free from predators, and observed the resulting reactions over a twenty-eight month period.

Interestingly, even though five pregnant female rats during this time-span could theoretically produce 50,000 health progeny for this size pen, Calhoun found that the population never exceeded 200 individuals, and stabilized at 150, a number often referred to as the Dunbar number. Moreover, the rats were not randomly scattered throughout the pen area, but had organized themselves into twelve or thirteen local colonies of a dozen rats each. He noted that twelve rats is the maximum number that can live harmoniously in a natural group, beyond which stress and psychological effects function internal force that break up the structure.

Next, Calhoun ran six experiments, between 1958 and 1961, in which inside of the barn he built three 10 by 14-foot rooms open to observation through 3 by 5-foot glass windows cut into the floor of the hayloft. This arrangement permitted observers to have a complete view of the lighted room at anytime of the day or night without disturbing the rats. Each room was further divided into four pens by electrified partitions. Each pen was a complete dwelling unit, containing a food hopper, a drinking trough, places to nest (skyscraper type burrows for observation),

and nesting materials. Ramp-like bridges passed over the partition electrified fences to connect pen I to pen II, pen II to pen III, and pen III to pen IV, thus creating a rectangular row of connected rat-cities or living units, each semi-permeable:



Calhoun's 1958 Norway rat density distribution studies

The results from the previous out-door study indicated that forty to forty-eight rats could healthily occupy each room. Thus, if the forty-eight rats were equally divided among four pens, each pen would accommodate a colony of twelve rats, the maximum number a normal stable group can maintain before stress develops. Moreover, Calhoun reasoned that if he let the population build up to eighty, i.e. twice the stability number, the colonies would suffer a population collapse or die-off. To remedy this, Calhoun periodically removed rats so to then artificially observe behaviors typical to specific population densities.

In the normal uncrowned state, the young but physically mature male rats fought with each other until a fairly stable social hierarchy was established. In the first of two studies, two dominate alpha males established territories in pens I and IV (as shown in the diagram). Each alpha male attracted a harem of eight to ten females. This type of arrangement was similarly balanced and consistent with the natural grouping among rats as observed in the original quarter-acre outdoor experiment. The remaining fourteen male rats and associated females distributed themselves in pens II and III.

Interestingly, as population densities began to build up in the system, what Calhoun calls 'behavioral sinks', aberrant behaviors such as disruptions in nest building, abnormal sexual advances, distressful courting rituals, increased levels of

fighting, decreases in reproduction, increased levels of filth, social disorganization, food gathering inabilities, etc., began to accumulate in pens II and III.

Normally, for example, females work hard to keep litters sorted out and if a strange pup was introduced into the nest, the female would remove it. When nests became uncovered, the young would be moved to a new location that was more protected. *Sink mothers*, conversely, failed to sort out the young. Litters became mixed; the young were stepped on and often eaten by hyperactive males who invaded the nests. When a nest was exposed, the mothers would start moving the young but would fail to complete some phase of the move. Young carried outside the nest were often dropped and eaten by other rats.[68]

From a chemical point of view, molecular dynamics ensued such that pens I and IV each resulted in having a density of ten rat molecules (ordered), whereas pens II and III each resulted in a density of fourteen rat molecules (disordered). Two alpha molecules first positioned into the end pens, farthest away from the boundary portholes; a number of alpha and beta females then attached to the spatial location of the α-male; the remainder beta, gamma, and sigma molecules, etc., distributed in the remaining space according to more elaborate rules. Rats in pens II and III, interestingly, had to work harder.

This is an interesting fact. In most thermodynamic system models, e.g. the original 1824 Carnot working body of air molecules, it is assumed, in unwritten form, that all of the molecules work the same amount in producing pressure-volume work. From Calhoun's studies, we see that this is not the case. This has to do with social structure; those higher in the structure will typically work less, e.g. executives play golf, queen bees lay eggs, etc. In the middle pens, for instance, three times daily there was a changing in the guard of the established hierarchy around the eating bins that was characterized by fighting and scuffling. Male sink rats, unable to establish stable territories, had to substitute time for space, and thus work harder.

The dominant feature to note in this study is that alpha males tend to distribute themselves within the system in a distancing relationship to that of the boundaries. This pattern occurs in most animal systems. In bird leks, i.e. breeding season mating grounds, for example, territories tend to be circular, such that the perimeter of the circle functions as the boundary. A strict hierarchy in leks accords the most desirable, top-ranking, alpha males the most prestigious central territory, with ungraded and lesser aspirants ranged outside. Females attract to these arenas in due course to be fertilized, and normally they make their way through to one or other of the dominants in the center.[69]

In high school cafeterias, a similar pattern develops. In recent 2006 study, 30 Chicagoans, aged 18-35, two of which were homecoming queens and one was alpha male (a designation based on the fact that he dated a homecoming queen) to draw detailed diagrams, from memory, of their high school cafeterias, showing the locations of each type of group, e.g. the in groups, the out groups, the most popular,

etc., the age characterization of each group, i.e. freshman, sophomore, junior, and senior, as well as seating densities, and to draw the exact location of configurations such as tables, food-lines, walls, and particularly doors.[70] Schools ranged between 800 to 6,500 students. Meta-analysis of the results showed clearly that the senior alpha male tended to sit at a central location, *farthest away* from the doors, i.e. perimeters or boundaries, of the cafeteria. According to a number of reports, as a sophomore, one would acquire status, year-by-year, the closer one sat to the senior table, and in particular in proximity to the alpha male.

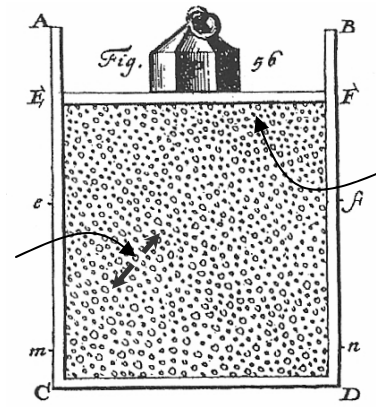
In sum, in both animal and human systems, alpha males tend to work less and in systems tend to situate themselves away from the boundaries towards the center of the room or system. The alpha and beta females then naturally position themselves around or in the vicinity of the stable area of the alpha male. The other beta, gamma, and sigma individuals will then position in the remaining more concentrated or pressurized areas and in doing so spend more time expending energy in the form of work. Being that animals, such as humans, rats, and birds, etc., are each different sized molecules, we should expect these arrangements, work, and pressure variations to exist in gas phase and liquid phase molecular systems.

Along these lines, related to these animal molecular density variation studies, is the conception of *pressure*, defined in terms of atomic or molecular movements, and that of *density*, defined in terms of atomic or molecular concentrations. The origin of these basic postulates derive from a theory developed by Swiss physicist and mathematician Daniel Bernoulli, as published in his 1738 *Hydrodynamica*, which laid the basis for the kinetic theory of gases. In this work, Bernoulli positioned the argument, still used to this day, that gases consist of great numbers of molecules moving in all directions, that their impact on a surface causes the gas pressure that we feel, and that what we experience as heat is simply the kinetic energy of their motion.

In formulating his models, Bernoulli had built on the ideas of Newton. In the 1687 *Principia*, Newton had hypothesized about inter-atomic forces, reasoning that in a gas system the atoms repel one another with a force that are inversely proportional to the square of the distance. Moreover, according to Newton, such a model explained the views of his associate Robert Boyle's gas theory (1662) that pressure P is inversely proportional to volume V:

$$P \propto \frac{1}{V} \qquad [9.8]$$

Using Netwon's ideas as models, in a section of the *Hydrodynamica* titled 'On the properties and motions of elastic bodies, especially air', Bernoulli positioned the view that heat Q is nothing but atomic motion and that the pressure P of the gas is due to the bombardment of the particles on the wall of the containing vessel:



Bernoulli's 1738 kinetic theory of gases diagram

The theory was not immediately accepted, in part because conservation of energy had not yet been established, as would be done by Joule in 1843, that heat during these years was viewed as a result of a substance called *phlogiston*, the 'matter and principle of fire', a concept developed by German chemist Georg Stahl in 1703, and that it was not obvious to physicists how the collisions between molecules could be perfectly elastic.

Due to these theoretical issues, the kinetic theory of gases, aside from a few publications, lay dormant for the next century. The turning point, however, came in 1856 when German chemist August Krönig published a short memoir on the kinetic theory, in which he argued that the kinetic energy of molecules is due to their translatory motion, and that this explains the properties of gas. Krönig reasoned that all the particles moved at the same speed and only in six directions: orthogonal to the six walls of a rectangular box. Stimulated by the publication of this paper, Clausius, who had been thinking about molecular motion even before his first article on thermodynamics in 1850, concluded that one must also include other kinds of molecular motion, such as collisional reversals, sideways impact motions, as well as rotation. Moreover, Clausius showed how one could estimate the fraction of the total energy that is translational by using heat data.

Clausius correctly pointed out that one could not assume that translational energy would be conserved in a collision, since there might be transfer of one type of energy into another. In addition, he outlined the view that some molecules might be moving faster than others and that during the evaporation of a liquid, resulting in cooling, those molecules with higher average velocities would be the ones that would escape the attractive forces of the other molecules, and the loss of energy would result in a fall of temperature. In human molecular terms, an example would be a highly energetic person who, at the age of adulthood, leaves a small town he or she grew up in to venture into the world, while those less energetic in nature stay.

In short, according to Clausius, whenever a body is moving against the action of a force, mechanical work must be done, and therefore, according to the first law of thermodynamics, heat must be supplied. Thus, for instance, 'in the passage from the solid to the liquid state the molecules do not, indeed, recede beyond the *spheres of their mutual action*; but pass from a definite and, with respect to the molecular forces, suitable [ordered] position, to other irregular positions, in which the forces which tend to retain the molecules in the former position have to be overcome'.

In this paper, Clausius also derived the fundamental equation for the product of pressure and volume, pV, in terms of the mass m of each molecule, the number N of molecules, and the square of the mean velocity u^2:

$$pV = \frac{1}{3}Nmu^2 \qquad [9.9]$$

The next significant turning point in the kinetic theory of gases occurred in 1859, in which, during this year, after reading Clausius' paper on the diffusion of molecules, Scottish physicist James Maxwell formulated the *Maxwell distribution* of molecular velocities, which gave the proportion of molecules having a certain velocity in a specific range. This was the first-ever statistical law in physics.[71] To elaborate on his views in relation to pressure, in his 1873 thirteen page article 'Molecules', published in the September issue of *Nature*, Maxwell states 'we are told that an 'atom' is a material point, invested and surrounded by *potential forces* and that when *flying molecules* strike against a solid body in constant succession it causes what is called *pressure* of air and other gases.'

Similar to these views, in 1873 Dutch physicist and chemist Johannes van der Waals published a treatise in which he outlined a revolutionary theory concerning the mutual attractions and interactions of molecules in the gas phase and how variations of these attractions result to create density, pressure, and temperature variations. Van der Waals, like Maxwell, had originally been inspired towards the development of a theory of 'intermolecular forces', after he had read the popular 1857 treatise by Clausius concerning the nature of the motion called heat.[72]

In his treatise, Clausius, as discussed, had showed how Boyle's law could be readily derived on the assumption that a gas consists of material points which move at high velocity, that this velocity is of the order of that of sound and increases in proportion to the square root of the absolute temperature. This treatise was a revelation for van der Waals, because it then occurred to him that if a gas in the extremely dilute state, where the volume is so large that the molecules can be regarded as points, consists of small moving particles, which is obviously still so when the volume is reduced, then so to must be the case down to the maximum compression of the gas and also in liquids, which by this logic must be regarded as compressed gases at low temperature.[72]

By this line of reasoning, van der Waals conceived the idea that there is no essential difference between the gaseous and the liquid state of matter, and that the factors or forces which, apart from the motion of molecules, act to determine the pressure must be regarded as quantitatively different when the density changes and perhaps when the temperature changes, but that they must also be the same factors or forces that exercise their influence throughout the state of matter, be it a gas, liquid, or solid. Van der Waals visualized that molecules in the solid amorphous state impede each other's motion owing to their close proximity. He also reasoned that the crystalline state has a molecular behavior and motion unique to itself.

On these views, van der Waals hypothesized that the reason why a non-dilute or non-ideal aggregate of moving particles fails to comply with Boyle's law are firstly variations in the attraction between particles and secondly variations in their proper volume. Moreover, van der Waals reasoned that the point-like entities of the gas or liquid particles must not be considered material points but small particles with a real volume in common with all bodies known in nature. Herein, in confirmation with van der Waal's postulates, we have clearly shown that all molecules have numerous delineations of quantum molecular reaction bubbles (photonic sensory spheres), each themselves confined to distinct molecular orbitals, which together define the volume and pressure in the system.

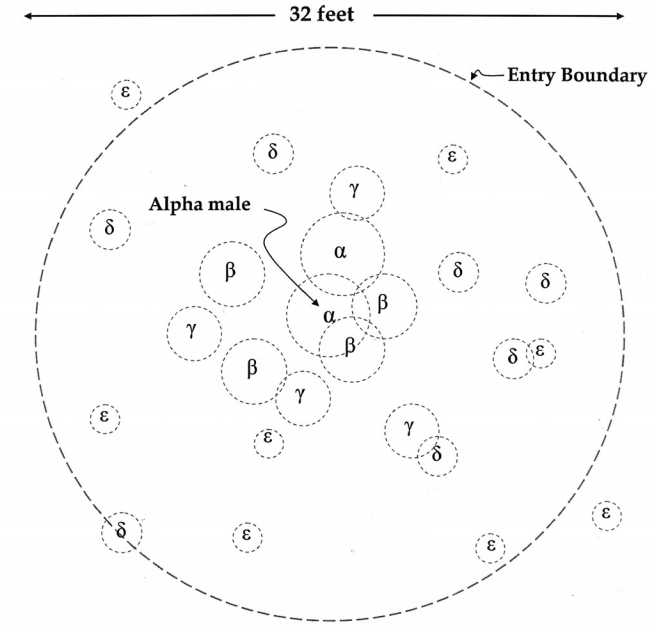
Thus, to remedy the problem associated with the non-compliance of real gases and liquids with Boyle's law, van der Waals conceived of the idea that there are variations in the mutual attractions between molecules, a factor now commonly defined as *intermolecular forces*, often characterized as weak yet defining social forces between molecues.[2] In his own words, in reference to these inter-molecular forces:

> "I have reduced this attraction, which acts in the whole volume, to a surface force which acts towards the interior and this, together with the external pressure, holds together the moving molecules."

In 1910, in a lecture entitled 'pseudo association', given before the Royal Academy of Sciences in Amsterdam, van der Waals outlined a view in which molecules associate to form larger complexes, particularly in the liquid state, that the attraction of molecules decreases extremely quickly with distance, and that the attraction only has an appreciable value at distances close to the size of the molecule. In addition, van der Waals delineated between two types of forces that act between molecules:

> *Pseudo-association* differs from *true-association* in that the latter is the result of new chemical forces which arise only when molecules are combined to form e.g. double molecules, whereas pseudo-association must be ascribed wholly to the normal molecular forces.

The existence of these two types of forces, which can diminish quickly, according to van der Waals, has two distinct consequences, namely they result in the formation of molecular complexes, such as cliques, but that they also lead to the creation of a surface pressure. To elaborate on this, van der Waals states that 'if we let the number of molecules that have combined into a complex be so large that it is possible to speak of a molecule at the center surrounded by a single layer containing almost as many other molecules as it is possible simultaneously, then for the surrounding molecules the attraction is directed towards the interior and acts to maintain the complex; and this part of its attraction is lost for the surface pressure.'



Lek Mating Arena

The human or biological molecular picture we envision here is that of the alpha Norway rat surrounded by his catch of nine to ten females, in pens I and IV, or that of the common bird lek (above), circular in geometry, in which the most available males are found in the center, or that of the captain of the football team, during lunch break, sitting at the desired choice table of the most elite people in the school, surrounded, naturally enough, in near table proximity, by several dozen of the most available females in the school.[70] In animal studies, in what is called the lek pecking

order it is found that the more physically-attractive birds, as defined via health, size, virility, opposite mate desirability criteria, etc., are given more spatial room in the *center* of the courtship and display assembly area, farthest away from the perimeter (exit or entry point).[73]

In the Lek mating arena, shown above, which is modeled on the sage grouse, each alpha-male (highest ranking), beta-male, gamma-male, delta-male, etc., guards a territory of a few meters in size on average, and in which the dominate males may each attract up to eight or more females.[74] In addition, each individual is shown with variations in personal space (quantum reaction bubbles), whereby higher-ranking individuals have larger personal space bubbles. Common bird leks typically have 25-30 individuals. Moreover, the less attractive animals, i.e. 'cold' mating potentials, are confined to the outer rims of the courtship circle. In an Uganda kob antelopes, for example, the bachelors are forced to roam the periphery of the lek, sometimes joining the nursery herd there but, their members are seldom if ever able to copulate.[75]

With other animals, such as the peacocks, hammer-headed bats, New Zealand kakapo, etc., it is well known that females are attracted to lek groups more than they are to males all by themselves and that the larger the lek, the more pronounced the attraction.[76] In each of these groups, according to van der Waals, only the forces acting outward from these molecules can contribute to the formation of internal pressure, and that for both pseudo and true association, the number of complexes formed increases with decreasing temperature and volume. In human terms, for example, the single hottest alpha male in a high school cafeteria setting will create social and desired relationship forces acting outward from his central location.

Nearing the concluding point of his 1910 Nobel Lecture, on the development of the *equation of state* for gases and liquids, van der Waals notes that it was of great importance for him to have been acquainted with Gibbs' 1876 treatises on the equilibrium of heterogeneous substances, which Gibbs had sent him shortly after their appearance. The central concept gained from Gibbs' treatises, according to van der Waals, was the principle that 'for a given amount of substance, equilibrium sets in if the free energy is minimum for the temperature and volume.' On this postulate, van der Waals introduced a parameter called the *degree of association*, which hypothetically exists between individual molecules, varying per relationship. Although he does not elaborate on this 'degree of association', he does point out that it is determined by means of Gibbs' equation, and that the factors related to this degree of association must be introduced into the equation of state.[77]

In human chemistry, we have further elaborated on van der Waals postulate that the degree of association between molecules is determined by the use of Gibbs free energy equation, e.g. [4.11], [9.4] and [9.5], through the thermodynamic development of the dodecabond theory, in which enthalpic (beauty) and entropy (brains) parameters can be employed as functions of free energy (work output), in which for a given

human molecular system, equilibrium sets in if the free energy is minimum for the temperature and volume.[78]

To defined a few points, an *equation of state* is simple a relation between state variables.[79] A *state variable* is any variable which represents the state of an object. In short, a state variable is a thermodynamic parameter that describes the momentary condition of a system, regardless of the path by which a system goes from one state to another, i.e. the sequence of intermediate states, such that the total change in any state variable will be the same. This means that the incremental changes in such variables are exact differentials. Examples of state variables include: density ρ, energy E, Helmholtz free energy A, Gibbs free energy G, enthalpy H, internal energy U, mass m, pressure P, entropy S, temperature T, and volume V.

In conclusion of his lecture, van der Waals states that the connection between the Gibbs free energy equation [4.11], the degree of association between molecules, and the development of a specific state equation needed to exactly define the state of a molecular system is obtainable and suggests that 'perhaps there is a direct way'. In this chapter, we have outlined this direct way.

With application to galactic formations and other systems, according to the α-molecule pressure, density, work-output, attraction-repulsion model outlined here, it is reasonable to postulate that both planetary formation as well as star formation may have coalesced in a similar manner. In other words, in a volume of empty space, it is reasonable to assume that first an α-molecule, or some variation thereof, attached, for whatever reason, to a certain local of space; thereafter, β-molecule, γ-molecule, and δ-molecules attracted likewise towards this center. In this progression, multitudes of attraction and repulsion tendencies working in coordination with volume or molecular, quantum bubble, energy regulatory, delineations, would thus actuate to form aggregates of larger size. As pressure increased centrally, the temperature would thus increase in a similar manner, such that hotter regions or hotter molecules would be found in the center.

This is in accordance with the high-temperature molten core of the Earth as well as existence of hot thermonuclear reactions internal to the structure Sun. To summarize, it is likely that all mobile gas, liquid, and surface phase molecular systems arrange via an α-β-γ type distribution and that, in some way, these processes have bearing on the formation of larger molecular assemblies.

The seeds of this temperature-pressure-volume molecular system interaction theory, to note, were first enunciated explicitly in 1704 by the great English physicist and mathematician Isaac Newton, in the famous 'Query 31' to the *Opticks*, in which he states, quite accurately:

> “Have not the small Particles of Bodies certain Powers, Virtues, or Forces, by which they act at a distance … but also *upon one another* for producing a great Part of the Phenomena of Nature? For it’s well known, that *Bodies* act *one upon another* by the Attractions of Gravity, Magnetism, and Electricity; and these Instances shew the Tenor and Course of Nature, and make it not improbable by that there may be more attractive Powers than these. For Nature is very consonant and conformable to her self.”

The *Opticks*, which was a treatise on light, concluded with a set of ‘Queries’. These Queries, especially the later ones, deal with a wide range of physical phenomena, far transcending any narrow interpretation of the subject matter of Opticks. They concern the nature and transmission of heat; the possible cause of gravity; electrical phenomena; the nature of chemical action. In the first edition, there were sixteen such Queries; that number was increased in the Latin edition, published in 1706, and then in the revised English edition, published in 1717. The first set of Queries was brief, but the later ones became short essays, filling many pages. In the fourth edition of 1730, there were 31 Queries, and it was the famous ‘31st Query’ that, over the next two hundred years, stimulated a great deal of speculation and development on theories of chemical affinity.

Chemistry took many of its problems and much of its viewpoint from the *Opticks* and especially the ‘Queries’ with which that work ends. Newton's suggestion of a hierarchy of clusters of unalterable particles formed by virtue of the specific attractions of its component particles led directly to comparative studies of interactions and thus to the tables of affinities of French chemist Étienne Geoffroy (1718), physician Herman Boerhaave (1724), and others later in the century. This work culminated at the end of the century in the Swede Torbern Bergman's 1775 table that gave quantitative values of the affinity of substances both for reactions when ‘dry’ and when in solution and that considered double as well as simple affinities.[80] In 1808, building on this foundation, German polymath Johann Wolfgang von Goethe used Bergman’s affinity tables as a basis for human behavior and in doing so wrote the classical novella *Elective Affinities*, a book that marks the start of the science of human chemistry, as discussed in the second volume.

Postscript

To clarify a few loose ends, first, we apologize to the astute reader as to the matter of the incomplete and crude nature of volume one. This book-set is only meant to be an approximate first draft on a basic elementary topic having been nearly untouched. Not since American navel engineer William Fairburn's 1914, 55-page book *Human Chemistry* has someone written a book on human chemistry. This two-volume book, subsequently, is meant to be a step up from the former. Lastly, to note, this publication was originally geared to be an 80-page booklet, just long enough to show a spine title. Over the course of writing it (18-months, 14 days), however, the book grew to over 800-pages. Publishers, however, tend to set their limits at about 700-pages per book. As such, Thims' *Human Chemistry* was split into two volumes at the last minute. Whatever ramifications this may cause, we apologize beforehand. As to price, in the future, hopefully, the author will find a venue to allow for a more budget-effective publication.

Contact author

Thank you for taking the time to read volume one. To help in the improvement of a possible second edition, please contact the author directly at the following email, with comments, suggestions, criticism, spelling, grammatical errors, theoretical issues, typos, ideas, disagreements, or any other concerns:

Email: humanchemistry@sbcglobal.net

Owing to time restrictions, to note, the first edition published swiftly in unpolished format; hence, any helpful comments, ideas, or constructive criticism would be appreciated.

References and Notes:

"If I have seen further it is by standing
on ye shoulders of Giants."
Isaac Newton, English physicist

Note: (a) Note 1: all humanthermodynamics.com and humanchemistry.net articles and pages, unless otherwise indicated, e.g. as in the *Journal of Human Thermodynamics*, were written by Libb Thims.
(b) Note2: in 2005 through 2007, the author started, wrote, or significantly contributed to 164 articles in Wikipedia, some material of which was tested for likeability and stability before inclusion here:
[URL]: http://en.wikipedia.org/wiki/User:Sadi_Carnot/Contributions
(c) Note3: we would like acknowledge those tireless Wikipedians who were involved in the editing and construction of these articles with Thims.

Back Cover: (a) Quote Schopenhauer: (Article) *Sex and Schopenhauer.*
[URL]: http://flatrock.org.nz/topics/society_culture/sex_and_schopenhauer.htm
(b) Quote Garbo: (Article) "*The Right Chemistry" Time Magazine, Feb. 15, 1993.*
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(b) Ted A. Erikson: BS Chemical Engineering – Illinois Institute of Technology, MS Chemistry – Illinois Institute of Technology
(c) Edward Sanville: PhD Computational Chemistry, University of Southern California.
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[URL]: http://en.wikipedia.org/wiki/Neil_Clark_Warren
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[URL]: http://www.humanthermodynamics.com/index.html#anchor_279
(c) As to scientifically answering the first question, i.e. "what happens when you die", this subject of study is called *cessation thermodynamics*. Essentially, whatever it is that defines someone as a person

(fundamental particles), it is a guarantee that this quantity is conserved, according to the first law of thermodynamics; and transferred either constructively or destructively into subsequent generations. A first draft workable model, built on this premise, was formulated in 2005:
(d) Thims, L. (2005). *Cessation Thermodynamics*. Chicago: IoHT Publishing; Bookstore URL: http://www.humanthermodynamics.com/HT-books.html#anchor_87
(e) For testing purposes, 100 copies of this (100-page) manifesto were given to an assortment of college-educated people who read it and then were queried to determine if they agree (overall) or disagree (overall) with the premise of the hypothesis presented; 87% of these reviewers agreed that the overall concept: *'sits well in their stomach'*.
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[URL]: http://www.humanthermodynamics.com/
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[22] Composition of the Sun (Georgia State University); Hyperphysics:
[URL]: http://hyperphysics.phy-astr.gsu.edu/hbase/tables/suncomp.html
[23] (a) Dozens of scientists have speculated in this direction, including: Newton, Faraday, Maxwell, and Gamow.
(b) Chemical gravitation, to note, should account, essentially, for Archimedes's principle (c.250BC), Kepler's three laws of motion (1609), Newton's three laws of motion (1687), Newton's law of universal gravitation (1687), Maxwell's field equations (1864), Gibbs' chemical thermodynamics (1876), Einstein's general relativity (1916), quantum field theory (1927), the molecular formulas for humans, the earth, and the sun, etc., as well as the effects of particle spin and movement, and a few other details.
(c) A *general theory of gravitational chemistry* is not something we will discuss in this short book; but it will likely be found that gravitation is the result of attraction due to the pull of charged spins (and currents associate therein); in the sun there are 10^{57} charged spins (and associative currents), in the earth there are 10^{49} charged spins (and associative currents), and in the human there are 10^{27} charged spins (and associative currents). Regarding inter planetary interactions, we can derive a quick molecular formula for the sun, i.e. what we would call a *sun molecule*; by comparing this to the *earth molecule*, it is reasonable to assume that two such thermally active molecules would be bonded to each other chemically via electromagnetic interactions, as is the case with all molecular bonds. The details of this hypothesis have yet to be worked out, but it seems to make a good deal of sense. Essentially, Maxwell's field equations (combined with Newton's, Poincare's, Einstein's, and Feynman's theories) should explain these planetary interactions and dynamic movement patterns. An example is the work done by Russian Anatoly Logunov, who uses Maxwell's field equations to describe planetary interactions. This is a variation of planetary chemistry theory.
(d) As to a general theory of chemical-gravitation these are just pre-cursory thoughts as to a general description of how the human-molecule is dynamically bonded to the earth and how the earth is connected to the galaxy. Essentially, in terms of the big picture of things, the human molecule is dynamically "bonded" in circular rotation patterns to the surface of earth substrate, i.e. earth-molecule, and the earth is dynamically "bonded" in circular rotation patterns about the solar plasma point mass, i.e. the sun or sun-molecule, and the sun is dynamically "bonded" in circular rotation patterns about the center of the galaxy, i.e. a galactic-molecule with a characteristic black-hole anomaly at its center; and our galaxy along with other galaxies are moving towards the great attractor at a speed of 1.4 million mph.
(e) All of these circular rotation patterns are due, at a good approximation, to interactions of positive and negative charges. There are four main effects resulting from these interactions which have been clearly demonstrated by experiment: 1. Electric charges attract or repel one another with a force inversely proportional to the square of the distance between them: unlike charges attract, like ones repel. 2. Magnetic poles (or states of polarization at individual points) attract or repel one another in a similar way and always come in pairs: every north pole is yoked to a south pole. 3. An electric current in a wire creates a circular magnetic field around the wire, its direction depending on that of the current. 4. A current is induced in a loop of wire when it is moved towards or away from a magnetic, or a magnet is moved towards or away from it, the direction of current depending on that of the movement.
(f) All of these effects are explained beautifully with Maxwell's field equations. Magnets, for example, cause attraction or repulsion due to congruent or geometric alignment of spins. In the human-molecule we have 10E27 charged spins (and associated currents), in the earth-molecule we have 10E50 charged spins (and associated currents), and the sun-molecule we have 10E57 charged spins (and associated currents). Each and every one of these moving and spinning charges and currents will have its own correlative electromagnetic field. It is reasonable to hypothesize that summations of these charges, currents, and fields coalesce or function together to produce an "apparent" gravitational force such to cause significant effect on large bodies with mass.
(g) Just as different sized *planets*, for example, have correlative gravitational "binding" or accelerative rates of attractions towards them so to do different sized *magnets* have different electromagnetic

"binding" or accelerative rates of attractions towards them. In both cases, we should find, those characteristic accelerations are due bulk action of spins. An astronaut on the moon, for example, would be less tightly "bound" as compared to earth-binding owing to a reduced spin count as found in the structure of the moon.
(h) As a second example, if it takes the electromagnetic force of "thrust" to propel a rocket (combustion) off the earth's surface, it might be reasonable to assume that it is the electromagnetic force of apparent "gravity" to which is holding the rocket to the earth in the first place. As a third example, in the preface section to George Gamow's famous 1962 book *Gravity* he states: "It is very probable that there is a hidden relation between gravity on the one hand and the electromagnetic field and material particles on the other, but nobody is prepared today to say what kind of relation it is."
(i) These are just some loose ideas. We can be sure at least several years would be needed to work out the mathematics of these hypotheses, so to find uniformity between Galileo's work, Newton's work, Maxwell's work, Poincare's work, Einstein's work, and Feynman's work, etc. (and others). This seems to be a puzzle that goes back many years. Einstein worked towards a unified field theory using Maxwell's equations as a basis, but could not complete the puzzle. Even as early as 1849, Michael Faraday states in his laboratory diary: "Gravity. Surely this force must be capable of an experimental relation to electricity, magnetism, and other forces, so as to build it up with them in reciprocal action and equivalent effect… Here end my trials for the present. The results are negative. They do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exits." Generally speaking, if this problem is approached from a chemical bonding point of view, the pieces of the puzzle should fall together nicely.
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(b) Stepanic, J. Stefancic, H, Zebec, M.S., and Perackovic, K. (2000). "Approach to a Quantitative Description of Social Systems based on Thermodynamic Formalism." *Journal of Entropy*, 2, 98-105. [URL]: http://www.mdpi.org/entropy/list00.htm
[44] Closed system (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Closed_system
[46] To note, this working piston-model is in the simplest form possible. As more details are accounted for such as variations on equilibrium, types of work done, system configurations such as those in which species enter or leave, gravitational effects, chemical reaction mechanism details, photon-electron

interactions, evolution window deviations, etc., the equations become more intricate, the descriptions become more elaborate and technical with more pages being consuming.
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(b) In Chinese, the symbol for the "catalyst" is the same as for "marriage broker" – a substance that brings molecules together in a reaction without getting involved in the reaction, or marriage. It can be used over and over again and won't affect the overall reaction.
(c) Substrate (biochemistry) - a molecule which is acted upon by an enzyme.
(d) Substrate (biology) - the natural environment in which an organism lives, or the surface or medium on which an organism grows or is attached.
(e) Substrate (chemistry) - the catalytic material upon which chemical species react.
(f) Substrate (marine biology) - the earthy material that exists in the bottom of a marine habitat, like dirt, rocks, sand, or gravel.
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(b) Note: Thermodynamic systems analysis is complicated subject. For example, taken in outline from above source, the simplest case-scenario is if we follow the path or action of a differential quantity of heat dQ_S, coming from the sun, as it passes into the earth-system modeled as a "working body" of molecules closed at the Karman line boundary to the flow of chemical species. In this case, the *first law of thermodynamics* tells us that the change in the internal energy dU_E of earth system will be equal to the difference of the heat received from the sun subtracted from the work done dW by the reactive chemical species of the earth system, or: $dU_E = dQ_S - dW$. If we wish to analyze biological systems that are "open" over the course of longer evolutions to the flow of chemical species and in which do other types of work such as: contractile work as in when a fiber shortens by an amount $-dl$, or if a quantity of electricity $-de$ is given off by a system at an electrical potential ψ wherein the electrical work is equal to $-\psi de$, or in which the transportation work to move $-dn$ units of a chemical species out of the working-body and into the surroundings wherein the chemical work for this process is given by $-\eta_i dn_i$, where η_i is the chemical potential for species i, i.e. change in the internal energy U of the system as one species enters, or if there gravitational work done, i.e. $-mgh$, and where X_k is any generalized unit of work, we must use a more complicated energy balance equation, such as:

$$dU = TdS - PdV + fdl + \psi de + mgh + \sum_{i=1}^{k} \eta_i dn_i + \sum_{k} X_k dx_k$$

To calculate the conditions for evolution for this more advanced process, the *criterion for equilibrium,* as defined by Gibbs, must be established and to this condition of stability, the system will strive.
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[59] (a) ibid, pg. 63.

(b) !Kung people (Wikipedia); [URL]: http://en.wikipedia.org/wiki/%21Kung_people
[60] Defense spending (per country); [URL]: http://borgenproject.org/Defense_Spending.html
[61] (a) Haynie, D.T. (2001). *Biological Thermodynamics*. Cambridge: Cambridge University Press.
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[62] Campbell, J. (1982). *Grammatical Man – Information, Entropy, and Life.* (pg. 33). New York: Simon and Schuster. ISBN: 0671440616.
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(b) This definition, essentially, is based on Sadi Carnot's 1824 definition: "*work* = weight lifted through a height"; which can also be expressed as *work = force (mg) x distance (h)*.
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(c) Heat (definition): "the noun heat is defined only during the process of energy transfer by conduction or radiation"; (Source): Baierlein, Ralph (2003). *Thermal Physics*. Cambridge: Cambridge University Press.
(d) Heat (definition): "any spontaneous flow of energy from one object to another, caused by a difference in temperature between two objects"; (Source): Schroeder, Daniel, R. (2000). *Thermal Physics.* New York: Addison Wesley Longman.
(e) Heat (definition): "energy in transit from a high temperature object to a lower temperature object"; (Source): [URL]: http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heat.html
Discourse on Heat and Work - Department of Physics and Astronomy, Georgia State University: Hyperphysics (Online).
(f) Heat (definition): "an interaction between two closed systems without exchange of work is a pure heat interaction when the two systems, initially isolated and in a stable equilibrium, are placed in contact. The energy exchanged between the two systems is then called heat." (Source): Perrot, Pierre (1998). *A to Z of Thermodynamics*. Oxford: Oxford University Press.
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(g) Note: if we want a more advanced definition of heat: of the 16 fundamental particles of the universe, Noblest Martinus Veltman, in his '03 book "Facts and Mysteries in Elementary Particle Physics", defines the 4 particles with integral spin to be the "energy" portion of the universe and those 12 particles with ½ integral spin to be the matter portion of the universe, approximately. Hence, in this manner, Heat can be defined as either: gluon, photon, boson, or graviton transit or exchange.
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Note2: If we know how the diameter of the earth has changes over its evolution, then we might be able to quantify pressure-volume work at the Karman line boundary. That is, has the diameter of the earth increased or decrease since its inception? We know, according to solar growth rates stored in fossil

records, that it's rotation rate is slowing, e.g. at the 2.5 BYA mark the earth rotated once every ten hours, and that at the 4.5 BYA mark it would have been revolving faster than one rotation per hour (Source: Whitrow's *What is Time* (1972), pg. 63.).
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(b) [URL] www.humanthermodynamics.com (site on the study of human thermodynamics)
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where *U* is the internal energy (SI Units: joules), *P* is pressure (SI Units: pascals), *V* is volume (SI Units: m^3), *T* is the temperature (SI Units: kelvins), *S* is the entropy (SI Units: joules per kelvin), μ_i is the chemical potential of the *i*-th chemical component. (SI Units: joules per particle or joules per mol), N_i is the number of particles (or number of moles) composing the *i*-th chemical component. In the infinitesimal expression, the term involving the chemical potential accounts for changes in Gibbs free energy resulting from an influx of particles. In other words, it holds for an open system only. For a closed system, this term may be dropped.

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(c) Similarly, as a first approximation, knowing that photons [γ] are weaker [100 times weaker specifically] in strength as compared to gluons [g_{ab}], we will then propose, that within the human-molecule/photon-bond 'relationship', that $9/10^{th}$ of the mass or energy equivalent of each respective bonded 'relationship' [reduced by a certain yet to be determined scaling factor] actually resides within the *chemical bond*, as shown above. Such an approximation also seems to align well with intuition. For example, in most human 'relationships', within each respective bond there exists a great deal of stabilizing energy exchange: conversational interaction, phone calls, emails, letter-writing, get-togethers, text-messaging, event participation, financial exchange, emotional exchange, visual exchange, sensual exchange, direct-contact exchange [fights, card-playing, tennis, volleyball, etc.], and so on. Each type of 'exchange' depends upon photon interaction at each respective key interface. Wherein the more of these activities one does spontaneously [arising from natural feeling or innate tendency without external constraint] with another bonded human molecule—the stronger the bond.

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(c) In September of '05, in a discussion between Libb Thims, Edward Sanville (computational chemist), Georgi Gladyshev (physical chemist and author of the 1998 book *Thermodynamic Theory on the Evolution of Living Beings*), and Lawrence Chin (philosopher and author of: *A Thermodynamic Interpretation of History,* [URL]: http://www.geocities.com/Athens/Agora/7654/thermex2.html), there was a general agreement that human potential and chemical potential are related.
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(b) Lehninger, A.L. (1973). *Bioenergetics—the Molecular Basis of Biological Energy Transformations, 2nd Ed.* London: The Benjamin/Cummings Publication Co. ISBN: 08053-61030; (pg. 27): Entropy and free energy are related by *an equation that combines the first and second laws*. This equation assumes that the temperature, pressure, and volume are constant, and it is applicable only under these conditions: $\Delta G = \Delta E - T\Delta S;$ in which ΔG is the change in free energy of the system alone, ΔE is the change in the total energy of the system, T is the absolute temperature, and ΔS is the change in the entropy of the system plus the surroundings (the universe).
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$$TdS \geq dU + pdV - \sum_k X_k dx_k - \sum_k \mu_k dm_k$$

Here, T denotes temperature, S the entropy, U the internal energy, p pressure, V volume, X_k any generalized force except pressure, x_k any generalized coordinate except volume, η_k chemical potential, m_k the mass of the k-th substance, which can be replaced by the number of moles.
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(b) To make this hot or not pallate of morphed images, photos from the site were sorted by rank and used [http://www.SquirlzMorph.com SquirlzMorph] to create multi-morph composites from them. Unlike

projects like Face of Tomorrow [http://www.faceoftomorrwo.com] or *Beauty Check* [http://www.beatycheck.com] where the subjects are posed for the purpose, the portraits are blurry because the source images are low resolution with differences in posture, hair styles, glasses, etc, so that here images could use only 36 control points for the morphs.
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(c) In a related 2006 *General Social Survey* conducted by Tom Smith, director at the National Opinion Research Center at the University of Chicago, researchers interviewed 27,000 randomly selected people from a cross section of America, who were asked questions about job satisfaction and general happiness. The top 10 most gratifying jobs and the percentage of subjects who said they were very satisfied with the job are: 1. Clergy—87 percent percent; 2. Firefighters—80 percent percent; 3. Physical therapists—78 percent percent ; 4. Authors—74 percent; 5. Special education teachers—70 percent; 6. Teachers—69 percent; 7. Education administrators—68 percent; 8. Painters and sculptors—67 percent; 9. Psychologists—67 percent; 10. Security and financial services salespersons—65 percent.
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Handpackers and packagers—24 percent; 4. Food preparers—24 percent; 5. Roofers—25 percent; 6. Cashiers—25 percent; 7. Furniture and home-furnishing salespersons—25 percent; 8. Bartenders—26 percent; 9. Freight, stock and material handlers—26 percent; 10. Waiters and servers—27 percent.
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[24] Free energy maps (see chapter five).
[25] (a) Data from 2,000+ graduating college students (UIC), specifically each person's degree correlated to salary (measure of work output, or free energy), the intellectual-difficult ranking of each degree (an inverse measure of entropy), and a physical-attractiveness ranking of each person's graduation photo (a measure of enthalpy), confirm these findings.
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(c) In short, physical attractiveness, neurological attractiveness, and work output show an inverse relationship just as do correlative thermodynamic terms enthalpy, entropy, and free energy, respectively. See: [URL]: http://www.humanthermodynamics.com/HT-mandates.html for a small example. The full derivation, however, requires about 20 pages.
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Geoffrey Miller's 2001 *The Mating Mind – How Sexual Choice Shaped the Evolution of Human Nature,* (3) Jared Diamond's 1997 *Why is Sex Fun? – the Evolution of Human Sexuality,* (4) John Girbbin and Jeremy Cherfas' 2001 *The Mating Game – in Search of the Meaning of Sex,* (5) Leil Lowndes' 1996 *How to Make Anyone Fall in Love with You*, (6) James Gould and Carol Gould's 1997 *Sexual Selection – Mate Choice and Courtship in Nature,* (7) Bobby Low's 2000 *Why Sex Matters – a Darwin Look at Human Behavior,* (8) Kevin Leman's 2001 *The Birth Order Connection – Finding and Keeping the Love of Your Life,* (9) Joann Rodgers' 2001 *Sex – a Natural History,* (10) Desmond Morris' 1997 *The Human Sexes – a Natural History of Man and Women*, (11) Nancy Etcoff's 2000 *Survival of the Prettiest – the Science of Beauty,* (12) Gillian Rhodes and Leslie Zebrowitz' 2002 *Facial Attractiveness – Evolutionary, Cognitive, and Social Perspectives,* (13) Brian Bates and John Cleese's 2001 *The Human Face,* (14) Helen Fisher's 1992 *Anatomy of Love – a Natural History of Mating, Marriage, and Why We Stray,* (15) Lynn Margulis and Dorion Sagan's 1997 *What Is Sex?* and (16) Niles Eldredge' 2004 *Why We Do It – Rethinking Sex and the Selfish Gene,* to name a few.

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(c) Note, however, that the full synthesis of the calculation of human molecular Gibbs free energy will invariably involve a thermodynamic formulation of the famous: "60 Traits Desirability Table". One can be found in the Evolutionary Psychology article [2003]: *"Mate Selection Criteria: A trait desirability assessment study of sex differences in Serbia"* [PDF]. Thus, an equation of the form: $G = f\{60\ Mate\ Traits\}$ will be the end derivation; as is tentatively shown via its functional thermodynamic components in a basic 60 Human Thermodynamic Traits Table, as linked to below:
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Book End: Mating of Large Red Damselfly (*Pyrrhosoma nymphula*) with male on top, in Ciney, Belgium, configured in the shape of a heart, a common symbol of love (photo) by: Luc Viatour, Date: 2006; (GNU FDL) Nikon case D50 optical Sigma 17-70mm,
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Preface: (1) Willard Gibbs (public domain); examples found in Lynde Wheeler's 1951 *Josiah Willard Gibbs – the History of a Great Mind* or at:
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(3) Michael Faraday (public domain); example here:
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(10) Graph: Are you a Giant Molecule (made by Libb Thims); using data as collected by a 2001 – 2007 Poll by Jim Eadon; [URL]: http://www.eadon.com/phil/humanchemical.php
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(8) Coal drawer image (public domain); Image is a copy of one from an official report of a parliamentary commission done in the mid 18th century;
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° Lehninger, Albert, L. Nelson, David, L., & Cox, Michael, M. (1993). *Principles of Biochemistry, 2nd Ed.* ("Principles of Bioenergetics", Ch. 13, pg. 365). New York: Worth Publishers.
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(3) Vacant and occupied bonding sites (made by Libb Thims); using MS Word.
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[URL]: http://en.wikipedia.org/wiki/Image:Molecular-collisions.jpg; which is a modified image of this public domain image made by Wikipedian Waprap on Dec 11, 2005:
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° Jason Hutchens [URL]: http://flickr.com/photos/jason_hutchens/
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° [URL]: http://en.wikipedia.org/wiki/Image:Tie-network.jpg
° [URL]: http://en.wikipedia.org/wiki/Interpersonal_ties; Similar model to this image found in Albert-Laszlo Barabasi's 2003 book *Linked – How Everything is Connected to Everything Else and What it Means for Business, Science, and Everyday Life.* (pg. 15). Plume Books.
(3) Human particle maps (made by Libb Thims); in page word box with MS drawing tools.
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(12) Stimulus response (diagram); description: A schematic representation of hearing showing: sound waves, auditory canal, ear drum, cochlea, auditory receptor cells, frequency spectrum of hearing response., and nerve impulse; sources:
° "Computation Provides a Virtual Recording of Auditory Signaling", Public Library of Science *Biology*, January 2005, Volume 3, Issue 1, e26, graphic ref. DOI: 10.1371/journal.pbio.0030026.g001.; date: January 2005; Original diagram by Tim Gollisch, Andreas M. V. Herz, and Public Library of Science. Converted to SVG by Wikipedian Iain on 12 June 2006 (UTC); published under a C.C. Attribution License.

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° Annotated [URL]: http://en.wikipedia.org/wiki/Image:Processing-of-sound.svg
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° Courtesy of Public Library of Science [URL]: http://www.plos.org/
(13) Symmetrical & Un-Symmetrical Man (made by Libb Thims); using MS Word.
(14) Swimmer, blind driver, three wanderers, two fisherman, horse spin diagrams (made by Libb Thims); hand drawn and annotated using MS word; modeled on the 1885 drawings of Ernst Mach as found in McManus, C. (2002). *Right Hand, Left Hand – the Origin of Asymmetry in Brains, Bodies, Atoms, and Cultures.* (pg. 166). Cambridge: Harvard University Press; originally found in Schaeffer, A.A. (1928). *Journal of Morphology* (45): 293-398.
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(2) High school sexual bonding network (diagram); source: Figure 2 "the direct relationship structure at Jefferson High" nodal diagram from the article "Chains of Affection: The Structure of Adolescent Romantic and Sexual Networks", *AJS,* Vol. 110, No. 1., July, (2004): 44-91.; rights paid to The University of Chicago Press ***cost = $90.00***. Image found here:
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(11) Personal space reaction bubbles (made by Libb Thims); using MS Word as based on measurement data from Hall's 1969 *The Hidden Dimension.* Image found here:
° Personal space [URL]: http://en.wikipedia.org/wiki/Personal_space
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(12) H_2 molecule, two nuclei, two electron (model) (made by Libb Thims); using MS Word; a similar model can be found in Mark Winter's 2005 *Chemical Bonding.* (pg. 27), Oxford University Press.
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